SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1923.

GENERAL PHYSICS.

2350. *Employment of Pendulum Entirely Free as Time-Keeper.* **G. Bigourdan.** (Comptes Rendus, 177. pp. 232–234, July 23, 1923.)—A pendulum, P, of great length *l* (corresponding to 2s. or 3s. oscillation), of great mass (100 *k* for example), of non-magnetic metal, suspended in the usual manner in an air-tight bell, has a hollow electric bobbin attached, through which an electric current *a* can be made to pass. At the base of a clock is a magnet, curved in an arc of radius *l*, placed so as to coincide with the axis of the bobbin, through which an electric current *b* can be made to pass; *a* and *b* are regulated by an auxiliary clock H, and can be used to restore at will its amplitude to P. G is the time-keeper that is to be controlled, and the author describes the method by which this is done by noting the amplitudes a_1 and a_2 at epochs e_1 and e_2 respectively during the periods of free swing of the pendulum. Considering the values of *l*, and of mass, the interval $e_2 - e_1$ may amount to as much as 4 days.

A. S. D. M.

2351. *Dependence of Sliding Friction on the Pressure Normal to the Sliding Surfaces.* **M. Polányi** and **E. Schmid.** (Zeits. f. Physik, 16. 5–6. pp. 336–339, 1923.)—This paper contains a record of experiments undertaken to ascertain whether sliding is impaired by pressure perpendicular to the sliding surface, *i.e.* whether an increase in the elasticity limits may be brought about. Tin and zinc crystals were used for the purpose, and experimental details are included. It is found that external pressure does not impair the sliding when of the dimensional order as the pressures necessary for promoting extension of the crystals. Also the sliding property is not to be regarded as a function of the applied shearing force per sq. cm. of the slip surface or of a friction dependent on normal pressure. The structures of the extended crystal bands were found by goniometric and röntgenometric means, and the conclusion drawn that inner changes are responsible for the data obtained and not merely the external surface.

H. H. Ho.

2352. *Testing of Barometers and Altimeters.* (Bureau of Standards, Circ. No. 46. [22 pp.] Washington, 1922.)—Describes the errors usually met with in mercurial and aneroid barometers, and the methods used in testing such barometers at the Bureau of Standards.

T. H.

2353. *A Component Anemometer.* **K. Fuji.** (Japanese Journ. Phys. 1. 9–10. pp. 101–106, 1923. In English.)—An anemometer has been constructed to give continuous records of the northerly and easterly components of the wind. Two small armatures with their axes perpendicular to each other, are carried by a framework supported in a uniform horizontal magnetic field; these are arranged to rotate at speeds proportional to the wind velocity. If the instrument is so fixed that with the wind due north one of the armatures is perpendicular to the field, the e.m.f.'s produced in the armatures are proportional to the northerly and easterly components of the wind; these are recorded by two potentiographs. Effects of hysteresis are avoided by making the armatures of magnetic material. The instrument was standardised by an accurate comparison with a Robinson's anemometer. A. W. L.

2354. *Polar and Axial Vectors in Physics.* **F. Emde.** (Zeits. f. Physik, 16. 3. pp. 209–210, 1923.)—The author discusses the remarks of L. Prandtl [Abstract 1743 (1923)] and remains of the opinion that not without arbitrariness can the physical vectors be divided into two classes, polar and axial vectors. J. J. S.

2355. *Polar and Axial Vectors in Physics.* **F. Fiala.** (Zeits. f. Physik, 17. 2. pp. 85–97, 1923.)—The author does not agree with F. Emde [see Abstract 813 (1923)] concerning the physical significance of the distinction between polar and axial vectors. He points out that in many cases, notably in electromagnetism, the distinction has a physical meaning, and that it is quite easy to determine whether a polar or an axial vector or scalar is demanded. J. W. T. W.

2356. *Measurement of the Size of Particles Suspended in Air.* **H. Rohmann.** (Zeits. f. Physik, 17. 4–5. pp. 253–265, 1923.)—A current of air was passed between two plates, one of which was earthed, while the other was charged, preferably negatively. A thin filamental current of artificial "smoke" or mist, produced by blowing air through very finely powdered material, was introduced into the main air current, and flowed with this, parallel to the plates, as a thin straight stream, when they were not electrified. In the lower portion of the charged plate was a narrow slit, and beyond this was a metallic point, directed perpendicularly to the plates, and charged to a high potential, so that it sent a narrow stream of ions through the slit, across the currents of air to the earthed plates. The result was that the suspended solid particles became charged, the amount of the charge of each depending simply on the area of the section exposed to the stream of ions, in the case of substances with dielectric constant unity, and in a more complicated manner when this constant differed from unity. The electric field between the plates imparted to the charged particles a velocity towards the earthed plate, and they were finally deposited on it. The position in which they are deposited depends on their size; and the theory is worked out so that it becomes possible to estimate the size of the particles from the distance along the plate at which they are deposited. In one experiment a rose-coloured mixture of Fe_2O_3 and BeO separated into two patches on the plate, one of which was pure white, while the other was red, with a weak transition zone. The theory of the method explains part of the physical basis of the electrical process of gas purification. H. N. A.

2357. *Motion of Ellipsoidal Particles Immersed in a Viscous Fluid.* **G. B. Jeffery.** (Roy. Soc., Proc. 102. pp. 161–179, Nov., 1922.)—

The subject is treated mathematically, the results being compared with those of Einstein. The hypothesis is developed that the particles will tend to adopt that motion which, of all the motions possible under the approximated equations, corresponds to the least dissipation of energy. From this hypothesis it is concluded that:

(1) Prolate spheroidal particles immersed in a fluid in laminar motion will tend to set themselves with their axes perpendicular to the plane of the undisturbed motion of the fluid. They will rotate about their axes with constant angular velocity, and the whole motion will be steady.

(2) Oblate spheroidal particles similarly immersed will tend to set themselves with an equatorial diameter perpendicular to the plane of the undisturbed motion of the fluid. They will rotate about this diameter with a variable angular velocity, and the whole motion will be periodic, but not steady.

(3) For motion in a capillary tube, the particles will tend to concentrate along the axis of the tube.

(4) For particles of given volume, the increase of the viscosity is greatest when the particles are spherical. A. B. C. L.

2358. *Motion of Ellipsoidal Particles in a Viscous Fluid.* **G. I. Taylor.** (Roy. Soc., Proc. 103. pp. 58–61, April 3, 1923.)—The experiments here described were undertaken to test experimentally an improved hypothesis recently introduced by G. B. Jeffery (see preceding Abstract). The hypothesis was that ellipsoidal particles immersed in a moving viscous fluid would assume certain definite orientations in relation to the motion of the fluid. It was found that ellipsoidal particles made of aluminium and immersed in water-glass do in fact take up the positions indicated by Jeffery, but that they take a long time to get to these positions. During the time which the particles are gradually approaching their final positions they oscillate in a way indicated by Jeffery's analysis. A. B. W.

2359. *Acceleration Measured by Means of a Flame.* **K. Prytz.** (J. de Physique et le Radium, 4. pp. 222–224, June, 1923.)—The flame of a candle in a closed lantern, protected against the influence of the external air, keeps its vertical position when the lantern is transported with a constant velocity. When the velocity is variable on displacing the lantern from right to left during the first part of the path traversed, the axis of the flame is directed towards the left, then it resumes its vertical direction and keeps this during the greater part of the path, while during the last period of the movement till the end, the axis of the flame points towards the right. This phenomenon depends on the acceleration of the motion, the point of the flame being always displaced in the direction of this acceleration. The movement is first accelerated and finally retarded, whilst it is almost uniform in the time between. The motion is further discussed in this note. J. J. S.

2360. *A Case of Adiabatic Movement.* **N. Kotschin.** (Zeits. f. Physik, 17. 1. pp. 73–78, 1923.)—This is a short mathematical paper dealing with the possibility of the change of vortex motion in a fluid under the influence of conservative forces and in the absence of any supply of energy, *i.e.* under adiabatic conditions. T. B.

2361. *Inversion of Bernoulli's Theorem.* **C. Jordan.** (Phil. Mag. 45. pp. 732–735, April, 1923.)—A mathematical study of probabilities, in which an application of Bayes' theorem for the inversion of Bernoulli's formula is made. It is claimed that the inversion has been brought into bad repute by the unsuitable presentation of the theorem generally adopted in the text-books. A. B. C. L.

2362. *Application of the Theory of Magnetism to the Calculation of Atomic Diameters.* **J. F. T. Young.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 49–61, 1922.)—A table of the elements, with the values of the atomic susceptibilities, shows certain relations between the values and signs of these susceptibilities and the positions in the periodic system; these relations, as far as sign is concerned, are also evident in an ordinary graph, showing the relation between atomic volume and atomic number, to which the signs + and − are attached to indicate whether an element is paramagnetic or diamagnetic. For atomic numbers greater than 10 the paramagnetic elements, without exception, occur on the descending slopes of the curves; the most strongly paramagnetic elements lying in the very minimum of the curves. The diamagnetic elements, with the sole exception of zinconium, are on the ascending slopes of the curves. The paramagnetic properties start weakly in each period, and increase to a maximum; there must in this be some repeated peculiarity of the atomic structure. Even with the Langmuir atom model a theorem, due to Lorentz, shows that electrons at rest in the atom will be set in motion by the superposition of an external field; and then the theory of magnetism applies. The author develops the theory so as to get an expression for the intensity of magnetisation, in terms of the number of orbits of given areas; and so arrives at the permeability per unit volume in terms of these numbers and areas. This is applied to both the Bohr and the Langmuir model. When once the radius of the innermost ring or shell of electrons is known, the value of the atomic radius can be found, by multiplying it by n^2 in Bohr's model, or n in Langmuir's; where n is the number of shells in the atom. The values obtained in this way for twenty-six diamagnetic elements are of the right order, when compared with Bragg's values. For Cl, Br, and I, figures are given for the atomic radii, as obtained by Rankine, and viscosity; Richards, compressibility; Landé, atomic structure; Davey and Bragg, X-ray data. These are all in good quantitative agreement, though the values of Bragg are low, since he is dealing with the atom, when it shares electrons with other atoms.

H. N. A.

2363. *Line Spectra and Atomic Structure.* **N. Bohr.** (Ann. d. Physik, 71. 1–4. pp. 228–288, May 23, 1923.)—A general account of the quantum theory of periodicity systems is given; its application to spectral problems is discussed, including effects produced by electrical and magnetic fields. The consideration of the gradual building up of the atom, by the addition of electrons, has led to a generalised picture of the constitution of the atom, which, in the light of the empirical spectral laws, permits of a free interpretation of the remarkable variation of the properties of the elements with the atomic number. In the alkali metals, which stand at the beginning of the periods of the system, before the last electron is captured, the electron orbits of the incomplete atom (*Atomrest*) form a closed configuration, of the same kind as that of the neutral atom of the preceding rare gas. The possible paths for the last joining electron are of two kinds, those which lie outside the orbits of the other electrons, and form Kepler ellipses, and those which in part penetrate within the region of those orbits. For the alkali metals the former condition holds with orbits for which $k \geqq 3$; and as a matter of fact the *d* and *f* terms of their spectra differ very little from the hydrogen terms, with evidence of a stronger force of attraction than in the hydrogen atom, as might be expected owing to the electric polarisation, which the outer electrons of the positive ion (*Atomrest*) induce, and the existence of which is fully analogous to dielectric phenomena. With the *s* and *p* terms, on the other hand, we meet, in general, with other conditions. For all the alkalies, except lithium, the stationary states, with $k = 1$, show orbits of the second class, which, in the case of the *s* orbits, actually come nearer to the nucleus than the two innermost electrons, which move in circular 1_1 orbits (the K electrons). For orbits with $k = 2$ the electron does not penetrate so far into the interior; but the effective quantum numbers not only differ from the hydrogen terms much more than those of the *d* and *f* terms, but differ in such a direction as would correspond to a weaker attracting force, if the orbits were confined to the outer region; this does not agree with the character of the atomic model. Such relations are shown graphically for a number of elements, in different positions in the periodic table, in a series of eight diagrams, showing some of the largest members of the different series of empirical spectral terms (s, p_2, p_1, d_2, d_1, f, etc.). The distance of the points representing them from the vertical boundary on the right of the figure is the numerical term value. A scale is provided, which gives the value of the effective quantum number n^*. The relations thus made evident between the different spectra are very interesting. In certain respects the observed spectra do not agree with the theory as so far developed; the coupling between the series electron and the rest of the atom cannot be regarded as analogous with the coupling between two simple periodicity systems, in the simple manner made use of in the theory. We are rather led to the view that, owing to stability properties of the atom which cannot be described mechanically, the coupling carries with it a *compulsion* (Zwang), which is not analogous, with the action of exterior fields of force, and the result is that the *Atomrest*, instead of having a single possible position in a constant external field, may be forced into two different positions; whilst, on the other hand, the electron, in consequence of the same compulsion, instead of the $2k$ possible adjustments in an external field, has only $2k - 1$ in the united atom. H. N. A.

2364. *Electron Paths in the Excited Helium Atom.* **M. Born** and **W. Heisenberg.** (Zeits. f. Physik, 16. 4. pp. 229–243, 1923.)—It has been shown by Kramers [Abstract 1751 (1923)] that the Bohr-Kemble model of the normal helium atom leads to an erroneous value for the ionisation potential, and Bohr (unpublished lectures at Göttingen, 1922) has investigated for the excited condition of ortho-helium a plane model with electrons revolving in the same sense and has found that the calculated value of the *p*-term agrees approximately, and the values of the remaining terms (*d*, *b*), not at all, with the empirical values. The authors have now subjected to systematic investigation all the possible types of path of the excited helium atom, and for solutions in accord with the quantum theory have calculated the energy values in order to ascertain if there are paths which yield accurate empirical terms. The result of this investigation is negative, so that application of the known quantum laws furnishes no explanation of the helium spectrum. Two alternatives alone are possible: either the quantum conditions are erroneous, or the mechanical equations do not suffice for the motion of the electrons even in the stationary condition. T. H. P.

2365. *The Quantelation of Unrestricted Periodic Systems.* **A. Smekal.** (Zeits. f. Physik, 15. 1. pp. 58–60, 1923.)—The customary term "mechanical" for the internal movements of an atomic system in its stationary states, has led to much confusion, especially where only Coulomb forces to a first approximation are considered, and Bohr has recently [see Abstract 1315 (1923)] avoided the term in favour of the more general expression "adiabatic principle" when considering the "Ehrenfest principle of the mechanical transformability of stationary states." In a previous paper [Abstract 2293 (1922)] the older terminology was used, and the present note is a restatement of results where such is required. The two papers should therefore be read in conjunction. H. H. Ho.

2366. *The Structure of Sodium Chlorate Crystals.* **W. Kiby.** (Zeits. f. Physik, 17. 3. pp. 213–250, 1923.)—The Laue diagrams, published by Jaeger in 1915, form the basis of the present investigation, while the observations of Kolkmeijer, Bijvoet, and Karssen, using the Debye-Scherrer method, and those of Dickenson, using the Bragg method, are also made use of. Vegard's results [Abstract 1039 (1923)] were published after the investigation was completed, and have not been taken into consideration. The paper contains a full account of the manner in which the available data, and particularly the intensities of the interference points in the Laue diagrams, were fitted together, so as to obtain a structure which, as nearly as possible, would explain the facts. It is assumed that the Na atom has given up one of its electrons, and the Cl five electrons, and that these six electrons are distributed to the three O atoms, so that the Cl atom with only 12 electrons has a charge of $+5e$ and the O atoms, each with 10 electrons, charges $-2e$. It is then assumed that, owing to the fact that the number of electrons is nearly the same for Cl and O, the diameters of the atoms are not very different. The space group T^4, arrived at by the previous investigators, is adopted, and Laue's structure factor is investigated. This contains five parameters a, b, p, q, r, which are to be determined numerically, so that the intensities calculated from them agree, as nearly as possible, with the Laue diagrams. Assuming that each O atom is equally far from each of the neighbouring Na atoms, which is in accordance with Bragg's principle of close spherical packing, that $a + b = 0{\cdot}5$, which agrees with the determinations of Kolkmeijer and Dickenson; and, adopting certain values for the radii of the spherical regions belonging to the different atoms, a structure is arrived at, with numerical values for a, b, p, q, r, which gives a similar calculated distribution of intensity amongst the interference points to that observed. The following points in the structure arrived at are of interest. Each O atom touches a Cl atom, and two Na atoms, and lies in the same plane with them. The Cl atom is equally distant from the above two Na atoms. The planes of the three O atoms, belonging to a Cl atom, cuts the diagonal of the lattice cube outside Na and Cl. H. N. A.

2367. *The Structure of Pentaerythrite, and a Graphical Method for Layer Line Diagrams.* **H. Mark** and **K. Weissenberg.** (Zeits. f. Physik,

17. 4–5. pp. 301–315, 1923.)—A graphical solution is worked out which gives the relations between the positions of the interference points on the cylindrical surface of the photographic film. Pentaerythrite crystallises in the ditetragonal pyramidal form, with the axial dimensions $a = 6\cdot16$ Å. and $c = 8\cdot76$ Å., and in the space group C_{4v}^{9}; the elementary cell is space centred, and contains two molecules of $C_5H_{12}O_4$. The symmetry of these molecules, and also that of the central carbon atom, is C_{4v}; the four substitutional groups $CH_2(OH)$ are similar to one another, and lie in the hemimorphic mirror planes of the space group C_{4v}^{9}; the simple bond C—C has the symmetry expressed by a mirror plane, as has been proved to be the case with the C—N bond in the structure of urea. It is not as yet possible to give values of the coordinates of the atomic centres, since the relative intensities of the interference spots have not been determined, and so the structure factor has not been worked out. A small discrepancy in the results is ascribed to the fact that, in addition to the K_α rays of copper, the source used gave off a small amount of a harder radiation, of half that wave-length, which produced a slight spurious effect.

H. N. A.

2368. *The Lattice of Tri-Phenylmethane.* **H. Mark** and **K. Weissenberg.** (Zeits. f. Physik, 17. 4–5. pp. 347–350, 1923.)—The authors consider the result of K. Becker and H. Rose, that there are three molecules in the elementary body, to be self-contradictory, since it is impossible to build up an elementary body, having rhombic symmetry, with three component parts (tri-phenylmethane molecules) of equal value, according to the theory of structures; and the assumption that these molecules are of unequal values appears to have no basis whatever. Attention is called to the necessity of adjusting the fragment of crystal examined, by means of the microscope, so that its axis is parallel to the axis of rotation; an error of 1° or 2°, with periods over 10 Å., makes the diagram perfectly undecipherable. The crystal used by the authors in experiments made to clear up this point, was rotated about the axis *a*, *b*, and *c*, and the measurements obtained for the elementary body were $a = 15\cdot16$, $b = 26\cdot25$, $c = 7\cdot66$; so that the axial ratio $a : b : c = 1\cdot152 : 2 : 0\cdot584$, which agrees with Groth's ratio $0\cdot5716 : 1 : 0\cdot5867$ if the *c* value is halved. Huggins gives $c = 7\cdot66n$, $b = 12\cdot95n$, $a = 7\cdot4n_2$, which agrees with the above if $n = 1$, $n_1 = 2$, and $n_2 = 2$. The number of molecules in the elementary body is eight.

Remark by **K. Becker** and **H. Rose.** (*Ibid.* pp. 351–352, 1923.)—In order to clear up the discrepancy with regard to the constitution of triphenylmethane, systematic investigations will be soon undertaken. The authors previously found 6·85 Å. for the parameter of the *c* axis; the crystal was turned about the long axis. The *a* and *b* values were obtained from the quadratic form $Q = k_{11}h^2 + k_{22}k^2$. No such large identity periods as those of Mark and Weissenberg were found. It seems possible that two different modifications have been examined, and the author's form may have hexagonal symmetry as previously noted. They consider that M and W should have made use of the quadratic form, particularly as the crystal was not adjusted to the direction of the rays by means of the goniometer, but only with the microscope. A remark by R. O. Herzog, at the end of another paper by M and R, in which mention is made of trimethylmethane, is noticed; the authors do not consider his criticism justified, and, with reference to certain statements made by him, call attention to the fact that the rotating crystal method goes back to Seemann and Schiebold. H. N. A.

2369. *A Modification of the Newton-Coulomb Law.* **C. Popovici.** (Bull. Astronomique, 3. No. 1. pp. 257–261, 1923.)—The author develops a series of orbital equations in which, in the general form, the radial attraction or repulsion, which may be gravitational, electric, or arising from the repulsive effect of light, is exerted in quanta of energy, by means of particles, waves, or any other mechanism, with a given frequency per unit of mass and of time, and with a finite speed of propagation. Absolute time and Euclidean three-dimensional space are assumed. Instructive comparisons are obtained with special cases in which the force is assumed to be continuous and, or, the speed of propagation to be infinite. G. W. de T.

2370. *On the Red Displacement in the de Sitter World.* **K. Lanczos.** (Zeits. f. Physik, 17. 3. pp. 168–189, 1923.)—Laue has recently published a criticism of Eddington's work [see Die Naturwissenschaften, 11. 382, 1923), in which he opines that the spatial variation of light velocity in the de Sitter world occasions a red displacement, and the present paper contains a detailed investigation of this suggestion. Eddington's hypotheses are reviewed and discussed. In a previous paper [see Abstract 1052 (1923)] the author has shown there to be no necessity for assuming a mass horizon at the equator of the de Sitter world, and on the basis then developed he now discusses whether a given red displacement proceeds from the metrical structure of the field or is to be ascribed to a Doppler effect. The conclusion drawn is in favour of the latter. For the red displacement of the sun's lines at the earth, the Doppler effect is combined with a gravitational effect, and the case of a static spherically symmetrical gravitational field is accordingly very fully examined. The paper is mathematical throughout, and an appendix refers to a recent communication by Weyl [Abstract 1774 (1923)] on the same subject. H. H. Ho.

2371. *Existence of an Energy Null Point.* **K. Bennewitz** and **F. Simon.** (Zeits. f. Physik, 16. 3. pp. 183–199, 1923.)—The authors open their paper with the remark that all of the many methods by which it has been sought to determine whether or no anenergy null point exists have been open to some objection. According to Planck's second form of his quantum theory the energy null point must correspond to a remainder of the ordinary energy both potential and kinetic. Contrary to the usual view that most of the molecules will be at rest in a domain exhausted of energy, there must remain a portion of kinetic energy which does not vanish at the null point, and must, consequently, be experimentally discoverable under favourable conditions. If, with Lindemann [Abstract 1389 (1910)], the fusion of a solid body be regarded as arising from the increasing amplitude of the molecular vibrations, and if his formula for the fusing point be modified by replacing the Einstein representation of a solid body by that of Debye, a standpoint is obtainable from which an experimental determination of the question should be possible. For its accomplishment more exact values of molecular data are required, especially the molecular spheres of action at the temperature of fusion, and the crystal lattices. The authors consider, however, that the very low fusing point of H, combined with the high value of its Debye function, $\beta\nu_m$, suggest the existence of an energy null point as being extremely probable. Moreover, the authors tabulate experimental figures obtained in the case of He, H_2, Ne, N_2, CO, A, O_2, showing their respective divergences from Trouton's law, a further indication pointing towards the existence of such a null point. G. W. DE T.

2372. *The Voigt-Lorentz Transformation.* **P. Straneo.** (Accad. Lincei, Atti, 32. pp. 607–611, June 17, 1923.)—In a recent note on the Voigt-Lorentz transformation, Somigliana refers to the fact that expressions of phenomena deduced by means of this transformation find their interpretation as much in the classical field as in that of Einstein, and concludes that no experiment can be invoked as decisive in favour of one or of the other interpretation. The author states that this conclusion must be taken with a certain restriction. The mathematical application of the transformation is not so important as its physical application, that which gives to it the signification eminently physical of being the transformation which must be used to pass from a given system of reference to another supposed in translation relatively to it, when it is wished at the same time also to take account of the principle of relativity. This application may be made according to two interpretations, one in the scheme of classical physics, the other in the scheme of Einstein. It is only between these two interpretations, both relativist, that experiment cannot be invoked as decisive. J. J. S.

2373. *Products of Radio-Active Disintegration in the Atmosphere and the Probability of their Origin in the Sun.* **H. Bongards.** (Phys. Zeits. 24. pp. 295–296, July 15, 1923.)—It has previously been shown by the author that measurements of the amounts of these products at great heights in the free atmosphere, even if they show parallelism with solar phenomena, will not prove the solar origin of the products unless the heights are such as to exclude every possibility of terrestrial origin. If, however, it could be proved that the large periodical variations of the amount of emanation take place in the same manner at a number of different places distributed over the earth, there could be no doubt of the cosmical origin of the emanation. Owing to difficulties due to the war the author has only recently seen the work of J. R. Wright and O. F. Smith in the Philippines, published in 1915. He now compares it with his own observations made at the same time at Lindenberg and finds a remarkable agreement between the curves from July 29 to December 2, 1913, the only exception being the month of September, in which month he assumes that local conditions affect the Manila measurements. Further investigation seems necessary and should be so organised that simultaneous observations of the emanation content of the atmosphere should be made at a number of different points on the earth where local effects are least likely to occur. It is not necessary that all the observations should be made by a strictly quantitative method since the wire method, which can be used easily in the free atmosphere, is capable of giving the required information as is shown in the comparison of the Lindenberg and Manila results.

H. N. A.

2374. *The Growth and Decay of Vortical Systems.* **S. Fujiwhara.** (Roy. Meteorolog. Soc., J. 49. pp. 75–104, April, 1923.)—The term vortex is taken as the total vortical field making a common revolution round an axis, to distinguish it from a vortical filament. Hence a vortex possesses individuality and exhibits animate growth, *i.e.* its intensity can, by its own action, increase beyond the intensity in the surrounding medium, taking energy from the latter. This is brought about by the attraction and amalgamation of vortices rotating in the same direction; vortices rotating in opposite directions repel each other. The conditions under which this process occurs are essentially unstable. The law of decay is an example of a much more general principle of a tendency towards uniformity, examples of which are found in many other physical laws such as the second law of thermodynamics and Boltzmann's principle of equipartition of energy. Vortices tend to occur in definite generations, thus, when the supply of energy to a vortex has been cut off, frictional forces reduce the velocity and secondary vortices are formed; this sequence continues until the distribution of energy is practically uniform. Vortices of different sizes have been observed without any of intermediate sizes. The laws of growth and decay are expressed mathematically and curves given for growth and decay for various values of the rate of decay. It is shown that for the growth of a vortex the presence of a certain finite amount of initial energy is necessary; this may be due to the viscosity of the fluid.

A study of the growth and decay of a number of cyclones suggests that three types occur: (1) Showing simple growth and decay, (2) in which the curves for growth and decay are the resultant of several of the simple curves, (3) a small class of erratic cyclones. Similar features are characteristic of the growth and decay of groups of sunspots.

A. W. L.

2375. *The Mechanism of Extratropical Cyclones.* **S. Fujiwhara.** (Roy. Meteorolog. Soc., J. 49. pp. 105–117; Disc., 117–118, April, 1923.)—The rate of increase of vertical vorticity has been studied by Hesselberg and Friedmann, who obtained the equation

$$\frac{dw_z}{dt}z = w_x\frac{\partial v_z}{\partial x} + w_y\frac{\partial v_z}{\partial y} + w_z\frac{\partial v_z}{\partial z} - w_z\theta - \lambda\left(\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y}\right)$$

in which v_x, v_y, v_z, w_x, w_y, w_z, are components of velocity and vorticity respectively, θ is the divergence, and λ is twice the vertical component of the earth's angular velocity. The variations at a given point are obtained from:

$$\frac{\partial w_z}{dt} = -\left(v_x\frac{\partial w_z}{dx} + v_y\frac{\partial w_z}{dy} + v_z\frac{\partial w_z}{dz}\right) + \left(w_x\frac{\partial v_z}{dx} + w_y\frac{dv_z}{dy}\right) - (w_z + \lambda)\left(\frac{\partial v_x}{dx} + \frac{\partial v_y}{dy}\right)$$

Consideration of the relative values of the terms in this equation shows that the effect of the second term is greatest and that of the third least; travel of the centre of the cyclone is caused by the first term, and variation of intensity by the third, while both of these are combined in the second term. The energy of the cyclone is obtained from the general vorticity of the field. A cyclone might be formed in the first place from small whirls in a low-pressure belt; these combine to form a cyclonic centre, and grow by taking energy from the horizontal eddies at the surface. This requires ascending air around the centre which is due to the inflow of air and thus consistent with the cyclonic centre being relatively cold. In the anticyclone the only term helping the circulation is the third, and enough energy cannot be taken in, although available in the field, to give steering or squall lines. A. W. L.

2376. *Aurora and Allied Phenomena.* **C. Chree.** (Roy. Meteorolog. Soc., J. 49. pp. 67–74, April, 1923.)—Presidential address. A. W. L.

2377. *Influence of Aperture, Focal Distance, and Magnification on Quality of Telescopic Images.* **R. Jarry-Desloges.** (Comptes Rendus, 177. pp. 248–250, July 23, 1923.)—The author concludes from observations made at Sétif in 1918, that diaphragms of less than a third the diameter of the objective cannot be usefully employed; that the rightful magnification depends upon, not only the planet but upon the apparent diameter of the planet's disc, for the smaller this is, the greater must be the magnification; and that the best focal length for refractors lies between 6 m. and 6·75 m. A diagram is given to show the correlation between the aperture and the quality of the images. For planetary studies at altitudes near 1000 m, the best instrument is usually a refractor of 34 cm. to 35 cm. focal length 6·35 m. to 6·50 m., the objective being over-corrected chromatically.
A. S. D. M.

2378. *Horizontal Flexure of Meridian Instruments.* **R. Baillaud.** (Bull. Astronomique, 3. 1. pp. 215–236, 1923.)—The first part is historical, and concerns the methods of previous workers. Next, the author describes how, by placing a plane mirror at the same time vertical (or inclined at a known angle ϵ) and perpendicular to the meridian, and by observing directly, and with the instrument reversed, the coincidence of the spider line and its image, the difference in the readings will give the flexure, so that the problem is reduced to finding the value of ϵ. The methods are explained by which this can be done, and a series of observations are given, made with the meridian instrument at Nice. The author concludes that the astronomical flexure for a given inclination of the instrument cannot be considered constant through long periods, probably owing to displacements of different parts of the telescope. In the case of a meridian instrument, stars observed at nearly the same zenith distance (for zone catalogues) do not vary much from flexure, and may be corrected by a mean value of the error; stars observed at very different zenith distances, have considerable flexure errors, and the errors must be determined for each night of observations as is done in the case of other instrumental constants. For the transit instrument of Nice, the mean value of the flexure varies according to whether the instrument is pointed north or south: $f^{N}_{60} = +0''\cdot 19$; $f^{N}_{60} = +0''\cdot 51$; and it may be taken that $f^{N}_{\zeta} = +0''\cdot 19 \dfrac{\sin\zeta}{\sin 60^\circ}$; $f^{S}_{\zeta} = +0''\cdot 51 \dfrac{\sin\zeta}{\sin 60^\circ}$. The flexure of the spider line was found to be negligible, being of the order of $0''\cdot 05$. A. S. D. M.

2379. *Great Meridian Instrument and Bouty's Micrometer.* **F. Lancelin.** (Bull. Astronomique, 3. No. 1. pp. 131–146, 1923.)—The first part is historical, dealing with the work and modifications of the instrument at Paris Observatory since 1863. Bouty's self-registering micrometer was installed in 1913; a description of it is given, including two cross-sections and five photographs of different parts. It is so fixed as to form almost one body with the transit, as is evidenced by the constancy of the readings of the declination wire and of collimation; the oscillations of collimation in polar distance have been practically halved by the use of the micrometer. The work in progress since March, 1913, has been the correction of the ephemerides of the moon and major planets given in the "Connaissance des Temps"; in these the polar distances have a comparable precision with those of right ascension. A. S. D. M.

2380. *Saha's Ionisation Hypothesis.* **H. H. Plaskett.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 311–312, 1922.)—Two criticisms of Saha's determination by using the Nernst heat theorem, of stellar temperatures from the appearance of a given spectrum of a star: (1) The use of the Nernst heat theorem implies that the cause of ionisation in stellar atmospheres is radiation from the photosphere. The author shows that in some B-type stars (effective temperature, 15,000° K.) if radiation is the only factor at work, at H_γ, 10^6 ergs will be absorbed radially and only 10^{-15} re-emitted radially, or in other words, an absorption spectrum should be obtained. But, in fact, an emission spectrum is found, so that there must be a more powerful source of ionisation than radiant energy, and since at 15,000° K. there are about 10^{14} free electrons per cubic cm., with velocities of thermal agitation sufficient to ionise H atoms, that source is in electron collisions, not in absorption radiation. (2) Saha takes no account of the relative abundance of different elements, and so predicts wrongly that in O-type stars (effective temperature 22,000° K.) the Balmer series should disappear rather before Mg_+4481, since there are doubtless more H atoms than Mg ones in the stellar atmospheres. (In the earth's crust there are 12 times as many.) In addition the relative abundance may alter in the course of stellar history; in an O-type star at 25,000° K., 4686 is a broad emission line, and probably He is more abundant relatively than on the earth. It seems probable that this gradual change in relative abundance accounts for the spectral changes in giant and dwarf stars of the same temperature. A. S. D. M.

2381. *Constitution of the Sun and Stars.* **A. Véronnet.** (Bull. Astronomique, 3. No. 1. pp. 147–194, 1923.)—A continuation of two earlier papers [Abstract 1710 (1921)]. By considering stars as gravitating masses of gas, the author seeks to decide the following points. Firstly, the variation of temperature T with the mass of the star M and the molecular mass of its constituents μ. It is shown that the radius of a star ρ at the maximum temperature of its centre is proportional to $\sqrt{M}$ and independent of μ, while the central maximum temperature is proportional to μ and $\sqrt{M}$. The ratio of the mean density to the density of the centre is proportional to μ and to $\sqrt{M}$. The hypothesis that the density of the centre is a limiting density for the gas leads to erroneous values for the radii and temperature of the stars, and has to be abandoned. Secondly, the temperature resulting from a sudden contraction of a star is considered. During a contraction, the mean temperature is always less than the mean maximum temperature, and the conclusion is reached that all radiating stars whose energy is supplied by contraction belong to the type of star which grows colder and contracts in the process. Thirdly, the author discusses the question of the mode of evolution of radiating stars, their expansion or contraction, and the equilibrium of a nebula. The result here is indefinite. For stars of monatomic or biatomic molecules, indefinite contraction and a rising temperature are indicated, while for tri- or poly-atomic molecules there will be infinite expansion and cooling. If the internal energy is entirely supplied by contraction, there will result contraction and increase of temperature. The small hot stars lie at one end of the curve of equilibrium, the cold nebulæ at the other. A large number of numerical illustrations are given and the analysis is full. A. Wh.

2382. *Distribution of Stellar Energies Made at Pic du Midi, in* 1920 *and* 1921. **J. Baillaud.** (Comptes Rendus, 177. pp. 424–426, Aug. 13, 1923.)—The stellar observations were made at altitude 2870 m., where the atmospheric absorption is small and constant; the stars and the black body were observed with the same optical system; the method of photometric photography was such as to bring in any uncertain photographic action as little as possible. The two luminous sources were impressed on the plate for the same time, and simultaneously, because of the uncertain action of the plate as regards latent images when under different conditions of humidity and temperature. The apparatus is described; the standard source of light being an electric lamp with a straight filament. In October, 1921, spectra of Alpha Lyræ, Alpha Aquilæ, Alpha Cygni, Alpha Ursæ Minoris, Epsilon Orionis, Gamma Orionis, Beta Orionis, Alpha Andromedæ, and Gamma Cassiopeiæ were obtained, and a diagram is given of Vega (type A) and Epsilon Orionis (type B), showing the wave-lengths as abscissæ and the logarithms of the energy intensities as ordinates. A. S. D. M.

2383. *Pressure in Stellar Atmospheres.* **P. Salet.** (Bull. Astronomique, 3. 1. pp. 195–206, 1923.)—The measure of pressure in stellar reversing layers is important, as pressure tends to displace rays towards the red and thus may vitiate the measures of stellar radial velocities; Adams gives a value for pressure of 12 atmospheres for Sirius, and of 7 for Procyon, and such might give rise to errors up to 7 km./sec., and render the mean value of radial velocities, for B stars, zero or negative, and for other spectral types, distinctly negative. The author points out that the lines named *a*, *b*, *c*, *d*, are unequally displaced to the red, and the displacement, apparently proportional to pressure, gives a means of evaluating this, independently of the radial velocity. The lines of group *d* have, for the same pressure, a displacement about triple that of *a* or *b*, so that the differences of radial velocity from these groups is about double the error sought for, and pressure can be evaluated with about the same precision as radial velocity. But the difficulty in obtaining accuracy in either is largely dependent on the physical conditions. The author has given, elsewhere, reasons for concluding that in the reversing layers of types between those of Arcturus and Procyon, the pressures are not much different from those in the sun. This is, however, contrary to Adams' results derived from the enhanced lines and those in the arc. He concludes, therefore, that for such stellar types, radial velocities are not vitiated by the effects of pressure. He discusses the pole effect to which is due the systematic differences in wave-lengths for most *c* and *d* lines, found by Adams and by K. Burns, and suggests that the magnetic fields in the sun may give similar pole effects in the reversing layer as in the electric arc. Fabry and Buisson have shown that the divergences between the solar and arc spectra are lessened when the arc is in vacuum. He discusses the most suitable lines for measuring pressure and shows why those of titanium should not be used. He does not consider that we come nearer the truth in rejecting all the lines, c_5 and d, because they are sensitive to pole effect. Moreover, these divergences in position of rays in the arc do not come into the comparison of solar and stellar spectra, because the physical conditions are fairly similar in these two sources. A. S. D. M.

2384. *Variable Stars.* **C. Gallissot.** (Bull. Astronomique, 3. 1. pp. 207–214, 1923.)—The two Cepheid variables, T Monocerotis and ζ Geminorum, have been observed at Lyons with a Nordmann photometer, which is designed, by the use of coloured screens, to show the variation of light in three different regions of the spectrum, red, green, and blue. The two sets of curves representing the observations made in 1920, 1921, and 1922 show a striking difference between the two stars. The curves for ζ Geminorum are practically the same in the three regions, but for T Monocerotis they differ in amplitude, blue having the highest and red the lowest maximum; and the difference is so considerable that near maximum the star changes in colour by about two degrees on the colour-scale of Osthoff. It is suggested that an absorbing atmosphere which varies periodically in density may play a part in the observed changes. M. A. E.

2385. *Proper Motions of Stars.* **J. Bosler** and **V. Nechvile.** (Bull. Astronomique, 3. 1. pp. 247–252, 1923.)—The blink microscope has been applied to measuring the proper motions of stars in Gemini, using two photographs taken with the Astrographic Equatorial of Paris in 1888 and in 1922. Out of 9000 stars, only 18 show considerable proper motion, which is a smaller number than was expected; and these stars fall into two classes, of magnitude 9·2 and brighter, and of magnitude 12·5 and fainter. A diagram is given showing the direction and amount of movements, and it is noted that there is a tendency for these stars to form groups and to move towards the south-east. M. A. E.

2386. *Duration, t, of Stellar Evolution in Terms of Effective Temperature.* **E. Belot.** (Comptes Rendus, 177. pp. 245–248, July 23, 1923.)—According to Russell's theory, stars pass through a maximum temperature in their evolution from giants to dwarfs, and Eddington says the ascending curve is shorter than the descending. The author obtains the equation: $\theta' = \theta'_m e^{-A^2[t' - t'_m + \tan\alpha(\theta' - \theta'_m)]^2}$; where tan α gives the dissymmetry of the curve of evolution which increases with the mass, and A is the length of time of the evolution. This curve gives two points of inflection, from which he infers that in the upward and in the downward curve there is a period of maximum speed of evolution, and he connects this with the paucity of giants in types F_0 to F_4 as compared with the number of stars in F_5 to F_9. The spectral type corresponding to this maximum speed of evolution depends only on the maximum temperature, θ_m and probably the duration of evolution for the same mass increases with the opacity of the stellar atmosphere. He computes that the sun has taken 156 millions of years to traverse the downward curve of its evolution from 8000° to 6000°. A. S. D. M.

2387. *The Apparent Distribution of Stars.* **S. Oppenheim.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 6. pp. 301–316, 1921.)—This paper is a discussion by means of the methods of harmonic analysis of the results obtained by Nort from the photographic observations made by Pickering and published in 1917 under the title "The Harvard Map of the Sky and the Milky Way." The apparent distribution of the stars is found capable of representation with a degree of accuracy of about 10 % by an ellipsoid, the coordinates of whose centre are, $A_0 = 230°$, $D_0 = 40°$, and these determine the direction in which the middle point of the stellar system lies as regarded from the sun. Its principal axes mark three chief directions in space, one of which coincides with the pole of the Milky Way, the second with the vertex of the stellar motions, and the third determined by the condition of being perpendicular to the two former. This ellipsoid, however, does not appear in simple form, but as a double picture with two chief directions coincident and the others rotated through 90°. A similar double ellipsoid has been proposed in the theory of the special motions of the fixed stars, yet two different pairs appear according to the mode of calculation, *i.e.* whether by the Bessel-Kobold dynamic method or from static data as in the theory of the distribution ellipsoid. The latter is identical with that obtained by means of star numbers only. The existence of such a double ellipsoid appears therefore to be characteristic for the system of fixed stars, and affords a contribution towards an explanation of the phenomena.

H. H. Ho.

2388. *Real Motions of Stars.* **B. Boss, H. Raymond,** and **R. E. Wilson.** (Astron. J. 35. pp. 26–34, May 19, 1923.)—A discussion of 520 stars of known radial velocity, proper motion, and parallex ($>0''\cdot005$), classified under "large velocities" ($<$ 80 km.) and "small velocities" ($>$ 80 km.). Large velocities show preference of motion towards galactic longitudes 130°–340°, small velocities towards 18°–360°. Scatter-diagrams of large velocities indicate a skewness in direction $+ 18°\cdot8$, perhaps due to our eccentric position in the galactic cluster, or to a local centre. The relation between giants and dwarfs, between bright and faint stars, and between early and late types, is similar to that between large and small velocity stars; the groups are similar in skewness, though different in dispersion. The space velocities of these 520 stars agree with the values of solar motion derived from proper motions rather than from radial motions.

A. S. D. M.

2389. *Families of Asteroids.* **K. Hirayama.** (Japanese J. of Astron. and Geophysics, 1. No. 3. Obs. Astron. de Tôkyô, Ann. Appendice II, pp. 55–93, Jan., 1923. In French.)—If, as in the case of comets, there exists a certain number of groups of asteroids which move in orbits almost identical, those asteroids had a common origin in a larger body, disrupted by some unknown cause. Kirkwood, Tisserand, and Mascart attempted unsuccessfully to detect such groups since they took for comparison the actual orbits which are varied by action of the planets. The author employs the theory of Lagrange and Laplace which treats the perturbations as small oscillations of a moving system, and looks rather to such elements which remain invariable for the detection of asteroidal families. The parent asteroid is supposed to have broken into a number of fragments at a remote epoch, and the equations:

$$u=\nu_0 \sin(g_0t+\beta_0)+\Sigma\nu_r \sin(g_rt+\beta r)\ ; \quad v=\nu_0 \cos(g_0t+\beta_0)+\Sigma\nu_r \cos(g_rt+\beta r)$$

express its secular variations; the orbit elements of the original asteroid being a, e, ω, i, and Ω. If the internal force, associated with the breaking up, has been very small, then the elements of a fragment are $a + \delta a$, $e + \delta e$, $\omega + \delta\omega$, and the effects of the variations, $\delta\nu_0$, $\delta\beta_0$, $\delta\nu_r$ are always very small, but the effect of δg_0 is never small if the time t is great. Thus after a long period, the point $((u, v))$ corresponding to each fragment, is scattered over the circumference of a circle upon which the points move by the effect of secular variation; similar results following for the secular variations of the inclination and the longitude of the node. Therefore a, μ_0, and ν_0 may be taken as the invariable elements by which the members of an asteroidal family may be recognised. The author gives in Table V the absolute magnitude g, the mean motion n, the tangent of the proper inclination μ_0, and the proper eccentricity ν_0 for each of the asteroids having mean motions from 500″ to 1150″; eleven diagrams in which μ_0, ν_0 are taken as rectangular coordinates and n is represented in spectrum colours, from which the families may be detected by inspection; and separate tables for the following families: Themis, Eos, Coronis, Maria, and Flora—the families being named after the earliest of its asteroids discovered. The number of the asteroids, belonging to families, is not less than 30 per cent. of the whole number. [See Abstract 2251 (1922).] A. S. D. M.

2390. *Movement of Planets in Resisting Medium.* **J. Chazy.** (Bull. Astronomique, 3. 1. pp. 239–246, 1923.)—The author reviews Tisserand's, Poincaré's, and Fatou's [see Abstract 2244 (1922)] work on this subject, and continues the work of the latter on a wider hypothesis, which is, in essence, that for a given system of values of the distance (r) of a moving point (M) from a fixed point (O), and of several other variables, the function R of absolute resistance of the medium is indefinitely small, if the velocity (v) is indefinitely small; and on the contrary, R is greater than a fixed positive quantity if v is greater than a fixed positive quantity. It is assumed that R is a function of five variables, provided that neither r nor v are zero. On these hypotheses, he shows that either (1) M collides with O after a finite time; or (2) the movement is continued indefinitely and M tends to approach indefinitely to O, as the time increases indefinitely; or (3) the movement is continued indefinitely and the distance OM increases indefinitely with the time. If, as in the case of Encke's comet, the resistance of the medium R may be discontinuous, the author concludes that if R and v are greater than fixed positive quantities for part only of M's orbit, then M will coincide with, or tend toward the point O and the whole orbit is contracted little by little until it is involved entirely within the resisting medium, and the case is reduced to those of the first hypotheses. A. S. D. M.

2391. *Henry Draper Catalogue, 19h. and 20h.* **A. J. Cannon** and **E. C. Pickering.** (Harvard Annals, 98. [259 pp.] 1923.)—A table of 23,181 stars between 19h. 00m. and 21h. 00m. whose spectra have been classified. The designations of the lines used in describing the spectra are generally the same as in previous volumes except in the case of the ζ Puppis lines. The author's previous classification is repeated in the introduction. A. S. D. M.

LIGHT.

2392. *Metallic Reflection.* **W. König.** (Ann. d. Physik, 71. 1–4. pp. 65–71, May 23, 1923.)—Drude's approximation formula for metallic reflection, the derived relation between reflective capacity of a metal and its conductivity, and the experimental confirmation by Hager and Rubens are first discussed, together with the contradictory observations of Righi and the later confirmatory ones of Lindman [see Abstract 1317 (1901)]. The Drude hypothesis for the metallic reflection of electric waves leads in the case of grazing incidence to remarkable phenomena (partly observed by Lindman) which are diametrically opposed to those given by light waves. The present paper is devoted to a theoretical study of these phenomena which is given after a detailed description of Lindman's observations. H. H. Ho.

2393. *Surface Layers and Metallic Reflection.* **H. Schulz** and **H. Hanemann.** (Zeits. f. Physik, 16. 3. pp. 200–202, 1923.)—The determination of the optical constants of metals is in practice mostly carried out in reflected light, though experiments with thin prisms have been made. Drude has come to the conclusion that reflection is affected, as in the case of non-absorbing substances, by a surface layer, the properties of which are not the same as those of the mass of the metal. Something may be done, by suitable modifications of the polishing and cleaning methods, to avoid the production of such surface layers; but only under very special conditions, which vary from metal to metal, is it possible to obtain surfaces which are really satisfactory from this point of view. A second possibility would be to obtain the constants of the actual surface, and to take into account in the calculations their influence on the reflected light; it would naturally be necessary to know the nature of the surface layer. Drude, and more recently Hausschild, find that a knowledge of a single constant, and of the thickness of the layer, suffices; so that it should be possible to represent the refractive index and absorption constant as functions of these two magnitudes; and, by measurements at different angles of incidence, to eliminate the influence of the surface layer; the matter is simplified, according to Drude, by the fact that the two constants come into the equations as a product, so that there is only one unknown quantity to be determined for the surface layer. The authors point out, however, that Drude's simple assumption with regard to the behaviour of the surface layer is not necessarily correct; and in the most general case an anisotropic absorbing layer must be considered, for the determination of which four values are needed. The structure of the mass of the metal must also be taken into account; since, even if with macroscopic observation there is apparent isotropy, finer microscopic observation may reveal anisotropy. H. N. A.

2394. *Absorption of Near Infra-Red Radiation by Carbon Dioxide.* **J. Okubo.** (Tôhoku Univ., Sci. Reports, 12. pp. 39–43, Feb., 1923. In English.)—An extension of the work of previous investigators to tri-atomic gases [see Abstract 286 (1918).] The apparatus employed was an infra-red spectrometer and a sensitive Rubens thermopile. It is shown

that the absorption band of carbon dioxide is really very complex and contains many separate weak absorptions arranged with some regularity.
E. G.

2395. *Spherical Aberration in Thin Lenses.* **T. T. Smith.** (Bureau of Standards, Sci. Papers No. 461. pp. 559–584, 1923.)—The author gives an elementary theory of the spherical aberration of thin lenses, using a notation which is due to Coddington where the aberration is expressed in terms of two factors, the shape and position factors. It is shown how to calculate quickly the aberration of any thin lens for any position of the object and to formulate a statement of the conditions under which the spherical aberrations of two thin lenses will compensate one another. The latter is confined to the simplest case when the lenses are close together (telescope objectives). The treatment is partly analytical, partly graphical. In addition there is a graphical solution of the problem as to the conditions under which such a two-piece lens may be achromatic, free from axial spherical aberration, cemented, and free from coma, and the shapes of the lenses necessary to satisfy these different conditions are discussed. The effect of a slight change in the shape is also indicated. T. H.

2396. *Refraction and Absorption of Light in Zinc Blend at Temperatures up to* 700° *C.* **M. Mell.** (Zeits. f. Physik, 16. 4. pp. 244–265, 1923.)—Details are given of a very complete series of observations of refractive index, and absorption, for a number of different wave-lengths, and at temperatures ranging from − 80° C. up to 600° C. for refractive index, and 700° C. for absorption. Difficulty was experienced at the higher temperatures, owing to the oxidation of the surfaces of the prisms and plates employed. The results are recorded in very complete tables and curves. The refractive indices agree well with the Ketteler-Helmholtz dispersion formula $n^2 = m + m'\lambda^2/(\lambda^2 - \lambda'^2)$ where $m = 3\cdot 0221$, $m' = 2\cdot 0998$ and $\lambda' = 253\cdot 2\ m\mu$. The refractive index increases with the temperature, and at a greater rate for light of short wave-length than for that of long wave-length; the formula $n_t = n_0(1 - \alpha t + \beta t^2)$ is found to hold, where, for the wave-lengths 436, 546, and 578 $m\mu$, α has the values $3\cdot 8695$, $2\cdot 7508$, and $2\cdot 5826 \times 10^{-5}$ and β the values $17\cdot 9$, $11\cdot 1$, and $9\cdot 5 \times 10^{-9}$. The transparency increases with increasing wave-length. There is a drop in transparency in the red, which appears to be due to the presence of an impurity; another drop in the extreme red is probably connected with the same impurity. The transparency falls off strongly with increase of temperature; the main absorption in the ultra-violet indicated by the dispersion formula, moves towards the visible part of the spectrum; the band in the red due to an impurity shifts towards longer wave-lengths. At 700° C. the substance is almost opaque; but a plate 1·63 mm. thick let through enough light to enable measurements to be taken through a considerable range of wave-lengths. H. N. A.

2397. *On a Method for the Measurement of the Dispersion of Artificial Double Refraction.* **O. Reeb.** (Ann. d. Physik, 71. 6. pp. 427–456, June 14, 1923.)—Previous work on artificial double refraction has been mainly concerned with homogeneous light, and has sought to find a relation between the optical and elastic properties of the materials investigated. Pockels and Ambronn have found a qualitative dependence of the double refraction on the wave-lengths of the light employed, and quantitative results have been given by Filon for glass [see Abstract 1496 (1907)] and by Köhler for coagulated gelatine solutions. In the present paper a process is described by which the dispersion of artificial double refraction is conveniently and accurately measured, and permits of comparison with the natural dispersion of the same substance. The exact adjustments, the sources of error and their influence on the measurements are very fully discussed. The method has been applied to gelatine solutions, but the Havelock theory has not thereby been confirmed. No simple connection appears to arise between the natural dispersion and that of the double refraction of the same substance in a deformed condition. The method has been adapted for measurements on substances possessing absorption bands in the visible spectrum, and has been tested on didymium glass. Tables of data are included. H. H. Ho.

2398. *Theory of Refraction at Black Screens.* **F. Kottler.** (Ann. d. Physik, 71. 7. pp. 457–508, June 14, 1923.)—A continuation of previous work on the Kirchhoff theory [see Abs. 1547 (1923)], and its connection with the Maxwell equations. The paper is mainly mathematical in treatment. **Errata** (*ibid.* 72. 4. p. 320, Aug. 21, 1923). J. W. T. W.

2399. *Remarks on "A New Interference Phenomenon in Doubly Refracting Plates."* **C. Schaefer.** (Zeits. f. Physik, 17. 2. pp. 155–156, 1923.)—The original paper was written by the author and K. Fricke [Abstract 1564 (1923)]. P. Selényi had already called attention to the theoretical possibility of such a double system of interference curves. T. K. Chinmayanandam has published a paper "On Haidinger's Rings in Mica" [Abstract 277 (1919)]; but has only dealt with the phenomena as observed with the telescope axis perpendicular to the plate; his theory is only an approximate one, dealing with the geometry of the phenomenon and not with the intensity of the ring system. His photographs do not show the double interference system, as do those of the author and Fricke; but only the "moiré" curves of minimum visibility of the systems, which result from the coincidences of the maximum of a curve belonging to one system coinciding with the minimum of a curve belonging to the other. P. N. Ghosh in 1922 published a paper, with two photographs, showing the phenomenon in a quartz plate, with unpolarised and with polarised light. The double refraction of quartz is small, so that in the first case it is hardly possible to see the two systems of lines. The various results described above agree well together and supplement one another.
H. N. A.

2400. *Study of Light Penetration into Sea-Water Made with the Kunz Photo-electric Cell with Particular Reference to the Distribution of Plants.* **V. E. Shelford** and **F. W. Gail.** (Puget Sound Biolog. Station Publ. pp. 141–176, Dec., 1922.)—The authors review the methods which have been used to determine the intensity of light penetrating into various depths of sea-water and describe the use of a Kunz potassium-hydrogen photoelectric cell. Difficulty in insulating the apparatus is overcome by covering insulating material with vaseline which is sufficiently plastic to push into any vacant spaces and permit air to escape when the apparatus is submerged. In considering the results of measurement the declination of the sun and the refraction of light by the water are allowed for. From the measurement of the intensity of light (of the wave-lengths for which the cell is active) at different depths and a knowledge of the transmission coefficients for other wave-lengths, the intensity of light of any wave-length at different depths is deduced. Between 5 and 25 m. the maximum energy for photo-synthesis lies in the blue during midday. It is found that in calm clear weather between 10 a.m. and 2 p.m. about 25 % of the light is shut out by the surface of the water and that in rough weather this may increase to 70 % or more. The first metre shuts out 20 % so that the great mass of organisms living in the first metre or less receive more light than has been supposed. From 8 to 10 % of the shorter wave-lengths entering the surface reach a depth of 10 m. The transmission determined for different metres indicate that floating materials differ from time to time, being concentrated at different levels. Surface conditions have a marked effect (in one case surface transmission changed from 67·3 % to 26 % in three minutes with increasing surface disturbance due to tides) and it may be expected that, if the lower limit of the distribution of organisms is determined by light, regions roughened by tides or waves will have a shallower limit than regions with calmer water. The relation of the penetration of different wave-lengths to plant distribution (especially brown and red algæ) is discussed. T. H.

2401. *A Solenoscope.* **S. Nakamura.** (Japanese Journ. Phys. 1. No. 3–4. pp. 21–27, 1922. In English.)—"Solenoscope" is the name given to an optical instrument, designed by the author in conjunction with S. Mikami, for examining the physical condition of the inside wall of a rifle barrel. A train of lenses is mounted in a long tube of diameter 6 mm. which can be inserted into the barrel to view or photograph any desired portion of the surface. A microscope objective forms an image of the wall at its focal plane, which image is brought to the end of the tube by five lenses, all of focal length about 68 mm. The lens nearest to the objective throws the image on to the second lens used as a condenser. The third lens is conjugate to the first with respect to this condensing lens and gives an inverted image of the barrel. This image is re-inverted by using the fourth lens as a condensing lens and the fifth to erect the image. A Zeiss eyepiece ($f = 18$ mm.) is used either to view or to photograph the final image. It is claimed that this arrangement gives an image of the greatest possible brightness all over the field. Sufficient illumination is obtained from a small 3-volt lamp inserted into the barrel. The instrument was found to reveal some minute faults of manufacture, until then unnoticed, and is at present being used to study the life history of a gun, *i.e.* the process of corrosion with the number of discharges. Sample photographs are given. T. H.

2402. *Effect of Barometric Pressure on Candle-Power of the Hefner Lamp.* **E. Liebenthal.** (Zeits. Instrumentenk. 43. pp. 209—224, July, 1923. From the Reichsanstalt.)—The author examines the results of the most careful determinations of the effect of atmospheric pressure on luminous intensity in the case of the Hefner lamp. The observations fall into two groups, *viz.* those that lead to a coefficient of about 0·015 per cent. per mm., and those that give a coefficient about 3 to 4 times as large as this. The discrepancy may be explained by assuming that the relation between candle-power and pressure is not linear but a curve of the second order. In the latter case, the smaller coefficient is the value of the slope of the curve at normal pressures, while the larger coefficient represents an average slope over a very wide range. The author finally gives the following formula:

$$\text{c.p.} = 1 - 0\cdot0055\,(x - 8\cdot8) + c_2\,(b - 760) - c_2''\,(b - 760)^2,$$

where x is the humidity and b the barometric height in mm., $c_2' = 0\cdot00015$ and $c_2'' = 0\cdot0000019$ approx. J. W. T. W.

2403. *Scattering of Light by Liquid and Solid Surfaces.* **C. V. Raman.** (Nature, 112. pp. 281–282, Aug. 25, 1923.)—Experiments were made by the author and L. A. Ramdas. Freshly split cleavage faces of crystals show extraordinarily little scattering. A clean piece of mica has surfaces which are invisible even when placed at the focus of a lens illuminated by sunlight against a dark background. Cleavage surfaces of rock-salt and Iceland spar are also good though not so perfect. Blocks of thick plate glass when freshly broken open show a blue superficial opalescence. When sunlight is concentrated on a carefully purified mercury surface in a vacuum the focal spot shows a bluish-white opalescence, the scattered light when observed in a direction nearly parallel to the surface being very strongly polarised with the electric vector perpendicular to the surface and of nearly similar intensity in all azimuths. The opalescent spot appears structureless, showing that it is a true molecular phenomenon. The surface-scattering by transparent liquids is due to the effect of molecular bombardment of the surface. In these liquids the phenomena are due to imperfect planeness of the surface. The surface opalescence of water has been observed. J. J. S.

2404. *On the Absorption and Anomalous Rotation Dispersion of Camphor Quinone.* **N. Wedeneewa.** (Ann. d. Physik, 72. 2. pp. 122–140, July 20, 1923.)—Camphor quinone has been found the most suitable substance for an investigation of the absorption and anomalous rotation dispersion, since it possesses absorption bands in the blue and violet parts of the spectrum but no others in the visible portion. All the measurements were carried out with monochromatic light, a full description being given of the apparatus and methods employed for determining the rotation, ellipticity, and absorption of pure camphor quinone dissolved in toluol. The results obtained are discussed from the standpoint of the Drude theory, and the activity coefficient calculated. A suitable method is also included for the measurement of phase-difference and dichroism. H. H. Ho.

2405. *The Tyndall Phenomenon in Liquids.* **R. Gans.** (Zeits. f. Physik, 17. 6. pp. 353–397, 1923.)—Section 1 of this paper discusses the Tyndall phenomenon of gases in which it is stated that the existence of lateral diffraction of light by the molecules of a gas or vapour has been established by the researches of Strutt, Gans, and Cabannes. Further, through the depolarisation of the Tyndall light, Gans has determined the particle form and the connection between this phenomenon and the Kerr effect. The theory of this procedure is now recapitulated in a different way to that employed earlier, since the present results are useful for application to solution phenomena. Section 2 then treats of the Tyndall phenomenon in liquids. Here it is found possible to employ Maxwell's theory in conjunction with thermodynamics, and the assumption is made that th most probable state of a gas or liquid is isotropic, but that anistr can also arise though with less probability. Use is made of the a tion that those substances which afford strong depolarisation of t scattered light also possess a high value for the Kerr constant. Section 3 deals with electrical double refraction, and section 4 with fluctuations of the dielectric constants. Section 5 then investigates the Tyndall effect in solutions, section 6 in optically active gases, and section 7 in solutions of optically active substances. Section 8 is devoted to numerical data and their discussion. Section 9 gives a very complete description of the apparatus employed in experiments with pure liquids such as water, benzol, carbon bisulphide, and with ultra-dilute solutions of cane sugar, NaCl, $MgSO_4$, $Ba(NO_3)_2$, $HgCl_2$, and LiCl. Section 10 is confined to work by previous investigators, and includes brief critical comments. The paper contains a very large amount of mathematical and experimental detail, the excellent agreement between which leaves no doubt as to the presence of the Tyndall effect, or of a connection between depolarisation and Kerr effect, and the existence of spontaneous transient anisotropy in liquids. H. H. Ho.

2406. *Application of the Radiometer Theory of E. Einstein to the Westphal Radiometer Measurements.* **G. Hettner.** (Zeits. f. Physik, 16. 5–6. pp. 345–352, 1923.)—The radiometer theory of Edith Einstein [see Abstract 1414 (1923)] is applied by the present author to the Westphal experiments with quartz thread radiometers. The indefinite character of the necessary black layers affords only approximation results, which, however, support the symmetrical character of the radiometer function as observed by Westphal and show satisfactory agreement with its general form. The correct dimensional order has been found for the pressure at which the maximum of the radiometer effect occurs. H. H. Ho.

2407. *Spectrophotometric Investigation of Dyes in Transmitted Light.* **N. Uspenski** and **G. Woronkoff.** (Zeits. f. Physik, 17. 2. pp. 112–116, 1923.)—The material was tested on the fabric in the following way. A small weighed quantity of dyed fluff was placed in Canada balsam between two parallel cover-glasses of known area. The specimen was then placed before the slit of a König-Martens polarisation spectrophotometer and rotated rapidly to produce a uniformly illuminated field. For comparison, the same light source was used in every case and also the same weight of material. A table of results is given for a large number of dyestuffs used on cotton, wool, and silk, and some absorption curves are drawn for pure crystal violet in aqueous solution and on silk. G. E. A.

2408. *Sensitiveness of Acid Coal-Tar Colour Substances to Light.* **J. M. Eder.** (Akad. Wiss. Wien, Ber. 130. 2*a*. No. 6. pp. 329–331, 1921.)—A new way for the production of durable photographic papers for visible and especially green light is given by the use of combinations of the aromatic para-diamido-bases, like benzidine, with acid tar colour substances, as eosin, chinolin-yellow, and others. The author has investigated the relative sensitiveness of these colour substances for white and coloured light, and finds that chinolin-yellow as well as eosin in combination with benzidine have a relatively great sensitiveness to light in the region from the green to yellow. J. J. S.

2409. *Action of Light upon Silver Bromide.* **R. Strömberg.** (Zeits. wiss. Phot. 22. pp. 165–176, July, 1923.)—After a short introduction in which the work of others is discussed, the present research is treated as follows: An account is given of the method and materials used. The silver bromide layer is put upon a very thin cover glass, such as is used in microscopy. Details of this process are given. Experiments are described which are carried out at a pressure of 145 mm. Hg and also others at lower pressures (0·0013–0·0033 mm. Hg). Since these results were obtained in 1917, although not previously published, a comparison is made at the end of the paper with results of other workers which have been received later. A. E. G.

2410. *Sensible Fluorescence of Gases.* **G. Cario** and **J. Franck.** (Zeits. f. Physik, 17. 3. pp. 202–212, 1923.)—Klein and Rosseland have shown from thermodynamic considerations that by the impacts of activated atoms with electrons, atoms, and molecules, transformations can take place unaccompanied by radiation, and such were named impacts of the second kind. The present authors have previously shown [see Abstract 783 (1923)] that the active energy may be related to a variety of energetic exchanges. Experimental material has now been accumulated for testing these assumptions, and a specially clear demonstration is afforded when a mixture of 2 gases is irradiated with light absorbed by only one component, while the other experiences energy variations through impact. If the changes produced are of a chemical character, then sensible photochemical reactions may be obtained which in special cases are manifested by the appearance of fluorescence. The conditions for obtaining such a result are discussed, mixtures of mercury and thallium vapours also of mercury and silver having been so prepared. Such activated fluorescence can be used for testing series relations, and the present paper describes an experimental attempt to increase the light intensity of the sensible fluorescence for mixtures of mercury and thallium, also of mercury and cadmium. Experimental details with diagrams and photographs are included. H. H. Ho.

2411. *Phosphorescent Sulphide of Zinc.* **A. A. Guntz.** (Comptes Rendus, 177. pp. 479–482, Aug. 27, 1923.)—The two crystalline forms of zinc sulphide, sphalerite and wurtzite, have the same chemical composition but not the same phosphorescence. The isomorphism of the sulphides of zinc and of cadmium permits of preparing a series of solid solutions of the two sulphides and thus producing a progressive change in the chemical composition of the system without modifying its crystalline constitution. The preparation of the zinc sulphide is not modified in any way, but a part of the zinc is replaced by cadmium. The crystals have the form characteristic of wurtzite. The phosphorescence of wurtzite is blue-green, *i.e.* the maximum of the emission band is situated in the blue-green. In proportion to the substitution of cadmium sulphide for zinc sulphide in the mixture there is a progressive displacement of this maximum towards the greater wave-lengths. Thus products are obtained with a red phosphorescence and probably even infra-red. The addition of increasing quantities of cadmium sulphide augments the absorption of the more refrangible rays of the spectrum. This addition also gives phosphorescent sulphides more easy to insolate by light. J. J. S.

2412. *On the Influence of the Electric Field on the Series Spectrum of Helium.* **W. Tschulanowsky.** (Zeits. f. Physik, 16. 4. pp. 300–313, 1923.)—According to the Bohr theory of atomic structure the helium atom consists of a nucleus, an inner and an outer electron. The optical absorption and emission phenomena are conditioned by the passage to and fro of the outer electron from the one stable orbit to the other. The inner electron only concerns optics in that it disturbs the orbits of the outer electron and so changes the frequency of the spectral lines. In helium two systems of series are known which are quite independent of each other, *i.e.* form no combinations. The present paper deals first with the single-line system, and then with the doublets. A very comprehensive description of these systems is given. The author states that if a method could be devised to measure the combination lines which lie near to the lines of the diffuse series, then a means will be to hand of evaluating the terms of higher order from observations in the visible and proximate ultra-violet part of the spectrum. This method will have a great advantage in the investigation of the helium spectrum, since the ultra-red series of both systems lie very near together. Now the question of whether the frequency of the combination lines in the weakest field can be disturbed, may be experimentally decided, and if a disturbance is to hand it will become possible to evaluate the position of the lines by an extrapolation. The author in the present paper records his measurements in the series spectrum of helium made from negatives prepared by Paschen as a contribution towards establishing the above methods. The disturbances referred to above are discussed in connection with these data. Experimental arrangements are also described. In the case of the single-line system certain lines were found to become very sharp and well separated from the diffuse ones, but the data is regarded as very incomplete. For the doublet system the components were found to coalesce when the field was withdrawn, whereas as the field is strengthened deviation was obtained first towards the violet and then towards the red. A new line also appeared which lay on the violet side of the fundamental and so near to it that its resolution was not practicable, although it likewise was displaced towards the red as the field increased in intensity. This new line points to a third quantelation. H. H. Ho.

2413. *The Fine Structure of a Class of Band Spectra.* **A. Kratzer.** (Ann. d. Physik, 71. 1–4. pp. 72–103, May 23, 1923.)—Under the special assumption that the resulting impulse moment of the electronic motion in the molecule has the direction of the total impulse moment, the mutual influence of the rotation and the electronic motion has been calculated and a term derived for the band spectra. From the correspondence principle suitable rules have been derived for the band spectra of homopolar molecules. It is then shown that the fine structure of the violet cyanogen bands and also of their disturbances may be obtained by means of the above derived term. From the latter also, the Hg bands 4017, 4219, 3728, Cd 4510 and 4310, and Zn 4327 and 4270, have been found and relations discovered among the separate bands. The impulse moment of the electronic movements has been shown to be a rational multiple of $h/2\pi$. Finally, the hydrides of Hg, Cd, and Zn are opined to be the carriers of the spectra on grounds which are discussed. H. H. Ho.

2414. *Ghosts of the Spectral Grating.* **C. Runge.** (Ann. d. Physik, 71. 1–4. pp. 178–186, May 23, 1923.)—Rowland's theory of so-called "ghosts" has been shown to explain the phenomena in the vicinity of the chief lines, and is now extended to those observed by Lyman in other parts of the spectrum. The above theory is based on the assumption that the furrows of the grating do not occur exactly at their correct places, and that the phenomena referred to are due to this defective distribution. This theory is submitted by the author to mathematical examination, from which it is found that the Lyman ghosts do not depend on the actual positions of the furrows alone, but that 2 periods occur, a small one from about 3 to 5 furrows, and a larger period which is not divisible by the first. Whether the periodic repetition of defect lies in the distances of the furrows or in any other irregularity is alike for the production of ghost phenomena. The author suggests it would be of interest to determine which defect of the ruling machine is responsible for these periods. H. H. Ho.

2415. *Missing Spectra.* **A. S. Eve.** (Roy. Soc. Canada, Trans. 16. Sect. 3. p. 313, 1922.)—When a narrow beam of parallel light falls on a sieve made of wire with various sizes of mesh ranging up to 300 wires to the inch diffraction bands and patterns are produced. By a calculation involving only simple proportion the wave-length of any light can be determined. A sieve with 300 wires to the inch was found to have the intervals between the wires precisely equal to their diameters. It necessarily follows that the even order spectra are entirely absent, while the odd order spectra are enhanced in brilliancy. J. J. S.

2416. *The Arc Spectrum of Rubidium.* **H. Reinheimmer.** (Ann. d. Physik, 71. 1–4. pp. 162–177, May 23, 1923.)—The present paper contains the measurements of the arc spectrum of rubidium and its comparison with that of krypton, to which it should correspond according to the Sommerfeld-Kossel displacement law, under the assumption that in the spark spectrum of Rb there is the simple ionised metal. The paper is replete with experimental data which receive exhaustive discussion.

H. H. Ho.

2417. *Regularities in the Arc Spectrum of Lead.* **K. W. Meissner.** (Ann. d. Physik, 71. 1–4. pp. 135–141, May 23, 1923.)—Of the elements of the 4th vertical series of the periodic table, only tin and lead have been investigated for regularities in the composition of their spectra. Kayser and Runge found 2 or more wave differences to be frequently repeated, and the author now makes a scheme for the line groups containing the whole of those from infra-red to ultra-violet. In all about 90 arc lines are available. A series of symmetrical groups has thereby been discovered containing no middle term and similar to those in the spectra of iron, molybdenum, and tungsten. The paper is mainly a compilation of data.

H. H. Ho.

2418. *Arc, Spark, and Absorption Spectra of Argon.* **W. W. Shaver.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 135–144, 1922.)—The spectrum of the radiation produced by the bombardment of argon atoms with electrons of various speeds has been studied by Déjardin [Abstracts 1762 and 1763 (1921)] with accelerating potentials from 16 to 80 volts. He found that with potentials from 16 to 33 volts the lines in the spectrum of the radiation produced belonged to the red spectrum. The blue spectrum due to the excitation of the ionised argon atoms began to appear with a field of 34 volts and the number of lines increased with increasing accelerating potential. The author has repeated these experiments, using potentials of 10·1 to 240 volts. In general Déjardin's work is confirmed, with the exception that it was found that a visible radiation persisted with a voltage of 10·1 volts after the arc had once been struck, whereas Déjardin found that the lowest possible voltage required to excite radiation was between 15 and 16 volts. A table of wave-lengths is given of the radiation produced in argon by electron bombardment with an accelerating potential of 10·1 volts, which was detected photographically. With accelerating fields from 16 to 30 volts the lines in the arc spectrum were found to belong to the red argon spark spectrum. As the grid potential was further increased to 31 volts, the blue or enhanced spectrum began to appear. At 54 volts apparently all the lines in the enhanced spectrum appeared as predicted by the Bohr theory. No new lines appeared when an attempt was made to bring on a third type of spectrum.

The absorption spectrum of ionised argon gas at pressures of 155, 5, and 2 mm. of mercury was investigated between $\lambda = 7000$ Å.U. and $\lambda = 2150$ Å.U. No absorption was detected. The gas at an equivalent pressure of 102·4 atmospheres was found to be transparent between the wave-lengths mentioned. J. J. S.

2419. *The Spark Spectrum of Aluminium.* **F. Paschen.** (Ann. d. Physik, 71. 1–4. pp. 142–161, May 23, and 71. 8. pp. 537–561, June 19, 1923.)—While investigating spark spectra, the author found a series of intensive characteristic triplets not hitherto recorded in spectroscopic literature and only occurring when the kathode cylinder was made of aluminium and the gas present was helium. Oxygen or chlorine in small quantities inhibited the appearance. The lines were found to belong to the spectrum Al II of simple ionised aluminium which consists of series of triplets and single lines. Alongside this spectrum was a series of characteristic lines belonging to the spectrum Al III of the doubly ionised aluminium atom and forming a series spectrum built on similar lines to the arc spectrum Na I of sodium but with the difference that the series term is 9 times greater. The paper contains a very detailed account of the experimental arrangements for studying this spectrum together with discussion of previous work on the subject. Part I deals in particular with the spectrum Al III which is interesting as affording a remarkable confirmation of Bohr's recent conclusions. Part II considers the spectrum of the simple ionised aluminium Al II. An enormous amount of experimental data is included, and a comparison is made between Al II, Mg I and hydrogen. The paper concludes with a section on the triplets of chlorine. H. H. Ho.

2420. *The Band Spectrum of Iodine.* **R. Mecke.** (Ann. d. Physik, 71. 1–4. pp. 104–134, May 23, 1923.)—Iodine, like all the halogens, possesses a typical pseudoline spectrum which under special conditions is seen to be composed of numerous fine lines. This spectrum may be obtained both as emission and absorption, and is opined to be due to the un-ionised iodine molecule. The band spectrum of iodine has special interest, since within the absorption region a resonance spectrum is known, and previous work by the author [see Abstract 1296 (1922)] has attempted to classify the resonance lines into series. The latter attempt was handicapped by the absence of a relation between the resonance and absorption spectra, and this is still incomplete notwithstanding numerous investigations on the subject. Detailed measure-

ments of the band spectrum are now described accompanied by 17 tables of data. Following these come the measurements of the resonance spectrum, and a general discussion of the results from which certain empirical relationships are proposed. [See also Abstract 1440 (1921).]
H. H. Ho.

2421. *The Band Spectrum of Carbonic Oxide.* **E. Hulthén.** (Ann. d. Physik, 71. 1–4. pp. 41–49, May 23, 1923.)—With discharges in Geissler tubes which are filled with CO or CO_2 there exists a series of band spectra which extend from the red to far into the ultra-violet. The nature of these bands is discussed, and it is found that the bands λλ5610, 5198, 4835, and 4393 of CO have an approximately congruent structure. Between the series of these bands simple linear relations exist. From the term presentation of the line frequencies it is concluded that on the one hand the bands λλ5610, 5198, 4835 belong to the same commencement condition of the molecule, and on the other hand the bands λλ4835, 4394 to the same end condition. It seems probable that the red bands λλ6622, 6073 also belong to the system.
J. J. S.

2422. *On the Intensity Distribution and the Origin of the Band Spectrum of Nitrogen.* **H. Kirschbaum.** (Ann. d. Physik, 71. 5. pp. 289–316, June 5, 1923.)—The observation that under certain conditions line and band spectra can simultaneously occur, gave rise to the assumption that these are afforded by different gas particles, and the atom is held to be the carrier of the line spectrum and the molecule of the band. In addition the splitting off of one or more electrons from neutral atoms or molecules in the glow discharge produce ionised atoms or molecules which can also be regarded as carriers of emitted light. The inter-relationships of such carriers are discussed in the introduction to the present paper, and previous work for nitrogen by Kayser, Konen, Stark, Angerer, and Hardtke briefly mentioned. The methods employed for determining the intensity distribution are then discussed in detail, including a description of the spectrograph, discharge tube, current sources, etc., employed. Observations are then recorded for the bands of the positive column for varying pressures, temperatures, and current strengths. Comparisons of intensities between the bands in the positive column for kathode rays and for canal rays, and between the bands for the canal rays and for the negative glow layer are next given. The intensity decline in the consecutive lines of a positive and negative nitrogen band is slower at the same gas pressure for canal rays than for kathode rays, and agrees approximately with that for the positive column at higher current-densities. High temperature in the positive column and activation of band emission by the impact of canal rays agree also in their effect that they strengthen the intensity of the higher line members of the band relative to the initial ones. This agreement appears to have its basis in that high temperature and impact of canal rays reinforces the oscillations of the atoms in the diatomic molecular carriers of the nitrogen bands. The paper is illustrated by numerous diagrams and photographs.
H. H. Ho.

2423. ***Absorption Spectra of Nitrosylsulphuric Acid and of the Complex Compounds of Copper Sulphate and of Ferrous Sulphate with Nitric Oxide.***

H. I. Schlesinger and **A. Salathe.** (Am. Chem. Soc., J. 45. pp. 1863–1878, Aug., 1923.)—The absorption spectra of nitrosylsulphuric acid dissolved in sulphuric acid of various concentrations show that appreciable quantities of the former acid remain undecomposed when the sulphuric acid is diluted with water to 50 per cent. and that, at higher concentrations of the latter acid, relatively large amounts of nitrosylsulphuric acid are present. One of the fundamental assumptions made by Raschig in developing his theory of the chamber process is thus disproved. Spectroscopic data confirm the existence of two complexes of the composition $FeSO_4$. NO and show that one of these is stable when the concentration of sulphuric acid is above 65 per cent. and the other when it is below 50 per cent. Spectra of the complex $CuSO_4$. NO are given and the spectra of these complex salts found to be identical with those of the so-called ferrous and cupric nitrosisulphonates. Examination of the spectra of solutions of nitric acid in concentrated sulphuric acid, before and after heating the solutions, show that nitric acid is not readily decomposed in such solutions into nitrosylsulphuric acid unless, indeed, the solution is highly concentrated with respect to nitric acid. The character of the absorption spectrum of nitrosylsulphuric acid favours the view that this acid is present in solution largely as nitrosulphonic acid. T. H. P.

2424. *Explanations of the Solar Spectrum.* **W. H. Julius** and **M. Minnaert.** (Ann. d. Physik, 71. 1–4. pp. 50–64, May 23, 1923.)—A criticism is given of different explanations of the solar spectrum. The authors conclude that less than half of the mutual influence of the Fraunhofer lines can be imputed to errors of measurement or photographic or other disturbances. The greater portion can be understood if it is assumed that the Fraunhofer lines substantially are dispersion lines. J. J. S.

2425. *Regularities in the Anomalous Zeeman Effect.* **W. Pauli, Jr.** (Zeits. f. Physik, 16. 3. pp. 155–164, 1923.)—The researches of Landé and Sommerfeld [see Abstract 904 (1922)] have afforded from the observed resolution of the lines in the anomalous Zeeman effect, the resolution of the combination terms in the doublet spectra of the alkalies and the triplet spectra of the alkaline earths. This work has later led to a natural generalisation. Heisenberg's attempt to explain by means of a model the empirical regularities which exist, has not been attended by satisfactory results and the present paper essays a simple extension of the results of Sommerfeld's quantum analysis of the Zeeman effect of the alkali and alkaline earth spectra in the case of a strong field for the whole of Landé's class of multiplets. A general rule has been found containing a symmetry condition for the term values during transition from strong to weak fields which leads by a surprisingly simple route to Landé's values of the resolving factor g for all multiplets of the class investigated. This rule is regarded as a general law which permits the evaluation of the g values when the term values for strong fields are known. Section 1 of the paper gives a survey of the known regularities of the complex structure and the general form of the Zeeman effect for small fields. Section 2 examines the Zeeman effect in the case of strong fields for Landé's class of multiplets. In section 3, the following rule (mentioned above) is derived, *viz.*: The sum of the energy values in all those cases of stationary states which belong to given values of certain quantum numbers, remains a linear function of the field strength during the entire transition from weak to strong fields. It is then applied to the calculation of Landé's *g* values. H. H. Ho.

2426. *X-Ray Structure of Luminescent Calcium Tungstate.* **E. Tiede** and **A. Schleede.** (Zeits. Elektrochem. 29. pp. 304–306, July 1, 1923.)—Very pure calcium tungstate, under the action of X-rays, gives an intensive blue fluorescence, with no subsequent phosphorescence. Even when it is prepared by precipitation of sodium tungstate with a pure calcium salt, phosphorescence occurs, and to get the pure effect ammonium tungstate must be employed. No traces of metallic impurities have been found in the purest fluorescing calcium tungstate, which could act like the known sulphide phosphores; but it is possible that minute traces of perhaps rare elements have escaped attention. The amount of fluorescence depends on the temperature of preparation, and this has been studied for different temperatures up to 1100° C., and shows an increase of fluorescence up to that point. The structure of calcium tungstate precipitated cold, precipitated hot, and after heating to 1000° C., was examined by the Debye-Scherrer X-ray method. The first showed no fluorescence and very weak crystal formation, the second had weak fluorescence and somewhat stronger crystal formation, the third showed strong fluorescence, and well-developed interference lines, showing marked crystal development, which agreed with the microscopical appearance. A specimen prepared in the cold three years ago, and which at that time showed no trace of X-ray fluorescence, now shows well-developed crystal structure, and strong fluorescence. H. N. A.

2427. *The Deflection of X-Rays in Microcrystalline Structures.* **N. Uspenski** and **S. Konobejewski.** (Zeits. f. Physik, 16. 3. pp. 215–227, 1923.)—The X-ray photographs obtained with rolled metal foil of Al, Cu, and Pt are similar to those shown by previous observers, and the authors came to the conclusion that they may be looked on as similar to those obtained with rotating crystals. The theory is worked out, from this point of view, and curves are drawn which, when the diminution in brightness from the centre outward is kept in mind, have the general appearance of the photographs. The method of attack differs considerably from that of Mark and Weissenberg [Abstract 1869 (1923)]; the results appear to be of the same general nature; they are as follows: for the three metals mentioned above the crystallographic axis 211 is parallel to the surface of the plate, and serves as axis of rotation of the microcrystals. The azimuth of rotation of the crystals does not exceed a certain bounding angle (up to 30°), the rotation taking place on both sides of a fixed mean position, which is characterised in such a way that in this position the symmetry axis of the second order is perpendicular to the surface of the plate. As to the physical causes which account for the arrangement of the microcrystals, attention is called to the fact that in all cases the axis of rotation was parallel to the direction in which the metal plate had been rolled. An arrangement of octahedral microcrystals in the rolled foil is suggested. Experiments made with thin iron sheets gave no result. H. N. A.

2428. *Secondary X-Rays.* **Puthomme.** (Comptes Rendus, 177. pp. 494–496, Sept. 3, 1923.)—At some mm. (3 to 6) above a photographic plate and in a plane parallel to it, metallic wires are placed in two directions at right angles to one another. The radiograph of this arrangement gives a clear reproduction of the wires; but if a metallic screen is placed beneath the X-ray bulb a radiograph made in these conditions shows for each of the wires three images; on each side of the initial image which is due to the rays emitted by the bulb, there now exists a new image resulting from secondary rays which have for origin the edge of the screen which is opposite it relative to the wire. The position of these secondary images is independent of the nature of the wires and of the tension used. The screen can function equally as a filter, by increasing its thickness, without altering the other experimental arrangements, the direct image disappears and the two images due to the secondary rays remain alone. This method can be applied to the quantitative study of secondary X-rays. Some experiments are described briefly. A. E. G.

2429. *Excitation of Characteristic X-Rays from Light Elements.* **J. C. McLennan** and **Miss M. L. Clark.** (Roy. Soc., Proc. 102. pp. 389–410, Jan. 1, 1923. Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 317–326, 1922. Abstract.)—Adopting the method employed by Hughes [Abstract 1309 (1922)] the authors have determined the critical absorption wave-lengths of the K and L series for the elements boron, beryllium, and lithium, and the critical absorption wave-length of the L series for carbon. It has been shown that the Moseley linear law connecting the square roots of the frequencies of the critical absorption K-series wave-lengths with the atomic numbers of the elements applies not only for the heavier elements, but also for the lighter ones down to lithium. For helium and hydrogen the square roots of the frequencies show a slight departure from the linear relation. The results fit in with the view that the Lyman ultra-violet series for hydrogen is the K X-ray series of this element and with the view that the convergence wave-lengths of the K series for helium is approximately $\lambda = 485{\cdot}5$ Å.

Additional series of critical potentials shown in the table, have been determined for lithium, beryllium, boron, and carbon. The table contains also the values found with the ionisation method for other elements by either Kurth or Mohler and Foote.

CRITICAL VOLTAGES AND L-SERIES WAVE-LENGTHS.

Element.	At. No.	Critical Potential, V	$\sqrt{V}$.	Wave-length × 10^8.	Critical Potential, V.	$\sqrt{V}$.	Wave-length × 10^8.
		volts.		cm.	volts.		cm.
Lithium	3	6·7	2·6	1840·0	12·0	3·47	1019·0
Beryllium	4	16·0	4·0	770·7	28·8	5·36	428·1
Boron	5	23·45	4·84	525·8	42·2	6·5	292·2
Carbon	6	33·00	5·74	373·7	72·0	8·5	171·1
Oxygen	8	49·72	7·1	248·0			
Aluminium	13	123·3	11·1	100·0			
Silicon	14	149·5	12·23	82·5			
Phosphorus ...	15	163·0	12·8	75·6			
Chlorine	17	198·0	14·07	62·3			

Two sets of values were observed. The first set showing the lower values of $\sqrt{V}$, has been interpreted as representing the first members of the L series for these elements, and the second set as representing the convergence wave-lengths of the L series for the same elements. In both cases the square roots of the critical voltages have been found to be directly proportional to the atomic numbers of the elements. Evidence has been adduced in support of the view that the Moseley law, which is known to apply for the L series of the heavier elements, ceases to apply for elements lighter than *argon*, and that the linear relation connecting the atomic numbers of these lighter elements with the exciting voltages of their L series, merges into the ordinary Moseley law when the element argon is reached.

Reference is made to the work of Millikan [Abstract 883 (1922)], who concludes from his experiments that the Moseley law for L-series spectra applies very closely for all elements from uranium to *neon*, and that for elements lighter than neon, the square roots of the voltages corresponding to the L-series critical absorption wave-lengths lie on a line which is slightly concave towards the atomic number axis, but which meets the line representing Moseley's law for the heavy elements at the element neon. Two views are therefore presented; according to the one, the Moseley L-series law is applicable for all elements from uranium to argon, and according to the other it is applicable for all elements from uranium to neon. Further work is necessary to clear up this anomaly.
E. A. O.

2430. *The Transfer in Quanta of Radiation Momentum to Matter.* **W. Duane.** (Nat. Acad. Sci., Proc. 9. pp. 158–164, May, 1923.)—The reflection by a crystal of X-radiation characteristic of the atoms in the crystal itself [see Abstracts 2052 (1922) and 2202 (1923)] does not appear to be explainable in a simple manner by the theory of interference of waves. A theory is developed mathematically, based on the hypothesis that the momentum of radiation is transferred to and from matter in quanta and that the laws of the conservation of energy and of momentum apply to these transfers. In the course of the argument an equation is obtained which can be reduced to Bragg's law of reflection of an X-ray by a crystal.
A. B. C. L.

2431. *X-Ray Analysis of Luminescent Boron Nitride and Particularly of Varieties which are Luminescent in a Flame.* **E. Tiede** and **[Mrs.] H. Tomaschek.** (Zeits. Elektrochem. 29. pp. 303–304, July 1, 1923.)—Boron nitride, prepared by different processes, shows different luminescent properties. Experiments have proved that this is due to the crystalline state, the amorphous specimens being non-luminescent, and the crystalline specimens luminescent. The first can be converted into the second by melting with an excess of boric acid or other suitable crystallisation medium, which can afterwards be washed out. X-ray determinations by the Debye-Scherrer method show clearly the difference between the two classes of preparation.
H. N. A.

2432. *Qualitative and Quantitative Chemical Analysis by Means of X-Rays.* **D. Coster.** (Zeits. Elektrochem. 29. pp. 344–348, Aug. 1, 1923. Paper read before the Deut. Bunsen-Gesell., Hanover, May, 1923.)—Since an element is defined clearly by its X-ray spectrum, it is possible to use X-ray spectroscopy in a similar way to ordinary spectroscopy, as a means of identification in qualitative analysis, and the method has certain weighty advantages. The X-ray spectra are much simpler than ordinary spectra, and the plates can be "read" much more quickly. The nature of the compounds or mixtures does not affect matters; and it is easy to prove the presence of an element, when only 1 % is present in a total amount of 1 mg. There are certain difficulties. Although the number of X-ray lines is limited, different observers have recently succeeded in proving the existence of many weak lines. Lines of different orders are produced, and very small impurities of the antikathode material will produce lines, so that, in many cases, there are several possibilities in explaining a given line. It is necessary to consider, not only the wave-lengths of the lines, but also their typical appearance, and the relative intensity of lines ascribed to a suspected element. It is also possible to use X-ray spectroscopy for quantitative analysis; this is done by means of a photometric study of the lines, by obtaining a photometric curve of the blackening of the photographic plate, by means of a microphotometer. The inner configurations of two neighbouring elements differ so little from one another that, with a good approximation, the ratio of the energies of two corresponding lines of such elements can be taken as equal to the ratio of the amounts of the respective atoms in the layer of material placed on the antikathode. An example is given of an analysis of the amount of hafnium in a specimen, obtained by comparison with tantalum. The height of the peaks on the photometric curves due to the $L\alpha_1$ lines of the two elements allows quite a close estimate to be made of their relative quantities. The solubility of hafnium phosphate was investigated in this way. Certain sources of error are discussed, such as the fact that the different parts of a photographic plate are not equally sensitive, that the lines are produced by reflection at different points in the analysing crystal, and correspond to different points of the antikathode. Methods are suggested for avoiding these sources of error. H. N. A.

2433. *Theory of X-Ray Spectra.* **A. Landé.** (Zeits. f. Physik, 16. 5 and 6. pp. 391–396, 1923.)—The system of X-ray terms has not, so far, been brought into complete relation to the different states of the atomic model, though Bohr and Coster have endeavoured to show the formal analogy between the quantum numbers of the X-ray terms, and the quantum numbers of Bohr's electron layers; but only for what they speak of as normal levels; the terms K, L_1L_3, $M_1M_3M_5$, etc. [Abstract 1398 (1923)]. For the anomalous levels, on the other hand, the term states L_2, M_2M_4, $N_2N_4N_6$, etc., with $ki = k_1 - 1$, which are divided from the neighbouring normal level with the same k_1 by a relativity interval, and from the neighbouring normal level with the same k_2 by a screening interval, B and C state that, in the present state of the theory, no complete explanation can be given. There are two alternatives; the anomalous $n(k_1k_2)$ term arises from the removal of an n_{k_1} electron or of an n_{k_2} electron from the atom. Arguments are produced in favour of both of these views; but on the whole the first alternative seems the more probable. The periodically repeated characteristics of optical spectra, in proceeding through the periodic system, and the special structure of multiplets; the interval relations and Zeeman effects of their terms, lead to the conclusion that each electron layer in the atom, in the closed condition, as a whole has zero rotation impulse, except the innermost 1_1 layer, with the impulse $1h/2\pi$. Suppose that one of the six electrons in the closed, zero impulse 3_2 layer is torn out, and that the five remaining group themselves in a new configuration. It is probable that four of them will combine to form a closed, zero impulse, 3_2 layer, and that there will be an isolated 3_2 electron. This last may be spoken of as the photoelectron of the X-ray term. The interior of the atom, in such an X-ray term condition, has now, in addition to layers without impulse, the innermost 1_1 layer, with impulse 1, and the X-ray photoelectron, with impulse k. Conditions are then similar to the optical case of the doublet term of the Na atom, so that we may expect two orbit positions of the X-ray photoelectron k, with respect to the inner impulse 1, since k and 1 can be compounded vectorially into two different values j of resulting impulse ; $k = 1$ forms an exception and j has then only one value. Thus each X-ray term is characterised by three quantum numbers, n the fundamental quantum number, k the arzimuthal quantum number of the X-ray photoelectron, and j the resultant quantum number for k and the impulse 1 of the 1_1 layer. (According to the newest views $j = k \pm 1/2$.) The author proceeds to apply these views, and shows that they give results of the correct order of magnitude, which show a probable relationship between the X-ray and the optical doublets, founded on the doublet interval.

H. N. A.

2434. *The Fine Structure of the Röntgen Series.* **A. Smekal.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 1–2. pp. 25–30, 1921.)—This is a preliminary communication dealing with the K, L, and M series, and a diagram showing the lines of these series in the Röntgen spectrum of wolfram is given.

A. E. G.

2435. *Spectra of X-Rays Produced by Multiple Atomic Ionisation.* **A. Dauvillier.** (Comptes Rendus, 177. pp. 167–169, July 16, 1923.)—Experimental verification of the theory of X-ray spectra due to multiple atomic ionisation. [See also Abstracts 912 and 1313 (1922).]

A. B. W.

2436. *X-Ray Spectroscopy and Metallic Compounds.* **K. Becker and F. Ebert.** (Zeits. f. Physik, 16. 3. pp. 165–169, 1923.)—Bain has found CuZn to be regular and space centred, Cu_2Sn tightly packed, hexagonal; he explains the fact that metallic compounds are, in general, less ductile than their components on grounds of lattice symmetry. Since the compounds have generally a lower symmetry, the possibility of forming sliding and translation surfaces is smaller ; cubic CuZn forms an exception. Results are given for six alloys using the Debye-Scherrer method. It appears that the above general rule of Bain does not hold. The compounds Cu_2Zn_3 and Mg_4Al_3 are regular (face centred cubic), while each contains a component (Zn and Mg) with hexagonal symmetry. On the other hand, $CuAl_2$ and CuAl are not regular, but apparently tetragonal or hexagonal, and quite different in structure from their component metals, which are regular, face centred. Cu_3Al and Ni_6W seem to be mixed crystals, and not real compounds. Cu_2Zn_3, Mg_4Al_3, and NiAl show new lines, which the simple lattices of the elements do not produce, which seems to indicate that they are real compounds. As far as metal compounds really exist, they form very small elementary parallelepipeds, containing only one molecule; this appears to distinguish them from other chemical compounds. The paper concludes with the following results for pure metals: Ta, space centred regular, $a = 3{\cdot}32$ Å., D = 16·3. Tl, tetragonal face centred, $a = 4{\cdot}75$ Å., $c = 5{\cdot}40$ Å., D = 11·02. Mn and U have not so far been satisfactorily worked out; they are in any case not regular. H. N. A.

2437. *Continuous X-Ray Spectrum.* **A. March.** (Ann. d. Physik, 71. 8. pp. 603–606, June 19, 1923.)—Remarks on a paper by H. Kulenkampff [see Abstract 1588 (1923)], on the same subject. A. B. W

2438. *The Relative Intensity of the K-Lines in X-Ray Spectra.* **M. Siegbahn** and **A. Žáček.** (Ann. d. Physik, 71. 1–4. pp. 187–198, May 23, 1923.)—A disc is rotated in front and in the plane of the spectral photographic plate, the edge of the disc being cut away, so that, when it revolves, different portions of a line are visible during different fractions of a revolution; and photometric curves for these different portions are obtained with the automatically registering instrument described by Lindh (Zeits. f. Physik, 6. p. 303, 1921), and with a Fabry photometer, in which a smoked glass wedge is employed. When it can be assumed that the blackening of the plate is proportional to the energy of the rays, which must be nearly correct when the wave-lengths do not differ greatly, it is possible by this means to adjust matters so that equal effects are produced in the photometer by different parts of the two lines to be compared; and instead of mere estimates of the intensities of the lines, in a scale from 0 to 10, such as has been previously employed, actual measurements of their relative intensities can be obtained. A certain amount of interpolation was used; that is to say, exact adjustment to equality was not always possible, and *small* differences of blackening were estimated. The fact that the width of the slit has to be made small, in order to separate the K_a lines which were compared together, affects matters somewhat, since theoretically this width should be greater than the extension in wave-length of the "lines" under investigation. The two photometers were found to supplement each other, the Fabry instrument giving the best results for fairly heavy blackening, while the thermopile photometer was more satisfactory for smaller blackening; the most accurate results obtained were under these conditions, and with this instrument. Curves and tables give the results obtained with the α_1 and α_2 lines of Cu, Zn, and Fe, and the β_1 line of Cu and Zn. H. N. A.

2439. *The Scattered Radiation Produced in Consequence of Thermal Movements during the Interference of X-Rays.* **H. Faxén.** (Zeits. f. Physik, 17. 4–5. pp. 266–278, 1923.)—The paper amplifies the theoretical treatment of the subject in the author's paper of 1918, which was founded on the work of P. Debye in 1914; as the result of his mathematical treatment of the subject he concludes that, with non-monochromatic X-rays, bands will be formed, starting radially from the primary spot in the Laue diagram, and directed towards the Laue spots; they may pass through the Laue spots and continue in the same direction on the other side, thus forming an asterism. Friedrich observed, in 1913, that using platinum antikathodes, after long exposure with sylvine crystals, dark bands appear on the plate, proceeding radially from the primary spot, just as might be expected as a result of thermal motions of the atoms. They may, however, be due to other causes; if, for example, the crystal is a conglomerate of small crystals, which are only approximately evenly directed, such asterisms will appear. Aminoff has shown that slight mechanical pressure on the crystal will produce the same effect. An examination of the behaviour of these bands with change of temperature would decide the question of their origin. Presumably another theory, built up on quite different suppositions as to the thermal movements, might explain the appearance of asterisms. H. N. A.

2440. *The Influence of Thermal Motion on the Interference of Röntgen Rays.* **I. Waller.** (Zeits. f. Physik, 17. 6. pp. 398–408, 1923.)—The first evaluation of the influence of the thermal motions of crystal atoms on the interference of Röntgen rays was made by Debye, and worked out more fully by Faxén [see Abstract 843 (1918)], who found the scattered radiation to possess a complicated character, but nevertheless deduced the result that a large intensity is to be expected in the vicinity of the Laue maxima. Schrödinger had previously given a very rigid treatment [see Abstract 680 (1914)] of the problem based on the Born and Karman theory, but unfortunately his evaluation only relates to a linear lattice, and the present author now considers the problem anew since he holds that Debye has used the Born and Karman method incorrectly, and an extension of the theory to other lattice types is desirable. Section 1 contains the calculation of the temperature influence on a simple crystal lattice, an easy method being shown for evaluating the interference intensity by using the normal coordinates of Born and Karman. Section 2 then investigates somewhat closely the Debye proposition for the introduction of normal coordinates, since this also leads to the same result as the corresponding process in section 1. In section 3, the fundamentals of the theory are briefly examined, and the experimental results of Backhurst are opined to agree fairly well with the theoretical demands. The paper is mathematical throughout. H. H. Ho.

RADIO-ACTIVITY.

2441. *Calibration Methods for the Emanation Electrometer.* **W. Bothe.** (Zeits. f. Physik, 16. 4. pp. 266–279, 1923. From the Reichsanstalt.)—Describes and discusses the methods employed in the preparation of normal radium solutions; they are shown to remain constant during a period of about two years. Repeated tests showed that their absolute value agreed with that intended, calculated from the amount of the original preparation contained in them, $3 \cdot 33 \times 10^{-9}$ gr. Ra ± 1 per cent. A simple form of gas pipette is described, by means of which a very small fraction $n = (5 \cdot 44_3 \pm 0 \cdot 01)10^{-6}$ of the original volume of gas containing emanation could be divided off from the rest, and introduced into the ionisation chamber. The original emanation was previously measured by means of γ-rays. Another method of calibration was to make use of emanation, which had decayed during a measured period; and, in order to calculate accurately the amount remaining, a careful new determination of the decay constant was made, which gave $\lambda = 0 \cdot 1812_2$ days^{-1} ± 0·1 per cent., making the half-value period of radium emanation $T = 3 \cdot 825$ days ± 0·1 per cent. H. N. A.

2442. *A Projection Electroscope for Measurements in Radio-Activity.* **H. M. Elsey.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 385–387, May, 1923.)—This is a description of an electroscope which has been designed to take the place of the slide carrier on a projection lantern. E. A. O.

2443. *Entrainment of Polonium with Bismuth Hydrate in Sodium Solution.* **Escher.** (Comptes Rendus, 177. pp. 172–173, July 16, 1923.)—When an acid solution of bismuth and polonium is precipitated by sodium, with excess of reagent, the polonium divides between the solid and liquid phases. The present investigation was undertaken to discover the law governing this division of the polonium according to the quantity of free sodium and the amount of bismuth. It is shown that the partition of the polonium between the two phases is purely a function of the number of molecules of bismuth and of the number of molecules of sodium contained in a definite volume of the mixture. A. B. W.

2444. *The Adsorption of the – B and – C Members of the Radium and Thorium Series by Ferric Hydroxide.* **J. A. Cranston** and **R. Hutton.** (Chem. Soc., J. 123. pp. 1318–1324, May, 1923.)—Further to Abstract 1595 (1923), the ratio of Th-B/Th-C adsorbed by ferric hydroxide is greater than the ratio of their isotopes, Ra-B/Ra-C, even when the initial different relative concentrations of the solutions are taken into account. The interval of time between preparing the solutions and the carrying out of the adsorptions was found to be an important factor in determining the ratio adsorbed. The influence of this time factor is in quantitative agreement with that expected from the theory put forward to explain the greater proportion of the – C member adsorbed with the lapse of time. E. A. O.

2445. *Shifting of Phase, Relative Motion and Radio-Active Disintegration.* **K. Fehrle.** (Zeits. f. Physik, 16. 5–6. pp. 397–407, 1923.)—The author shows that the formula, previously given for atomic weights, gives a shifting of phase, which for element 72 amounts to 1·5 units along the x axis. From the purely geometrical point of view the phenomenon behaves as if the atoms move forward in the system of standing waves, regarded as a fixed network, which transmits the reciprocal action between the whole of matter and the atom; and as if the vibrations were retarded in such a way that the waves, arriving at and leaving the atom, are always in opposite phases. A new equation is given, which allows for this action. For the author's views with regard to radio-activity and the position in the periodic system of the rare earths the original paper should be consulted. He thinks it probable that a difference in the rate of radio-active action, at different periods in the year, may be observable, on account of differences between the velocities of the earth through space. H. N. A.

2446. *Theory of Motion of α-Particles through Matter.* **R. H. Fowler.** (Cambridge Phil. Soc., Proc. 21. pp. 521–530, and pp. 531–540, June, 1923.)—A mathematical paper (in two parts) which attempts to throw light on certain special points of importance in the theory of the retardation of an α-particle in passing through matter. Reference is made to the theories of Bohr [Abstracts 1930 (1913) and 1720 (1915)] and Henderson [Abstract 190 (1923)]. A short abstract is not possible. A. B. W.

2447. *The Wave Theory of α-Rays.* **G. Jaumann.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 5. pp. 189–216, 1921.)—The author has previously worked out the theory of electrical longitudinal waves of small amplitude, which, however, do not have a limited range like the α-rays. He now shows that, if the amplitude is large, the range will be small, and that the velocity will drop rapidly towards the end of the range, as is observed in the case of α-rays. Such an electric wave, as it travels on with absorption of energy and consequent ionisation of the gas through which it passes, will behave like a sea wave striking a shelving beach. At a certain depth "breakers" are formed; the succession of equidistant blackened points observed by Reinganum, when α-rays strike a photographic plate with steep incidence, are ascribed to a succession of such breakers. It appears to be theoretically possible for sharply bounded, thin, longitudinal rays to exist, which would have all the properties of the α-rays; and it is perhaps as well to be reminded that even the apparently self-evident fact that they are of corpuscular nature cannot be directly proved. H. N. A.

2448. *Braking of α-Rays in Fluids and Vapours.* **K. Philipp.** (Zeits. f. Physik, 17. 1. pp. 23–41, 1923.)—Full descriptions of the apparatus employed with fluids and vapours are given; and also of the methods of measurement and the necessary precautions. Bragg's additive law of braking power of compounds has been tested for fluids and vapours, and it has been shown to hold for normal fluids, and for vapours; associated fluids have a larger braking power for α-rays than is obtained by adding together the braking powers of their constituents. The braking power of solutions in relation to their concentration has been examined; and, assuming Bragg's law, formulæ for calculating the braking power have been constructed. An attempt has been made to calculate the unknown braking power of a component in a solution from the measured braking power of the solution. The measurements made with potassium and sodium hydrates give an abnormal braking power for potassium and sodium. H. N. A.

2449. *Secondary β-Rays Produced in a Gas by X-Rays.* **P. Auger.** (Comptes Rendus, 177. pp. 169–171, July 16, 1923.)—A detailed examination of the electron tracks, in C. T. R. Wilson's expansion apparatus, produced when X-rays traverse a chamber containing gas. Simultaneous photographs are taken in two directions mutually perpendicular. The speed of the β-rays, estimated from the length of the tracks, depends on the nature of the atom from which it emerges, but does not vary (at any rate within certain limits) with the frequency of the primary X-rays. For example, with chlorine, the tertiary β-rays have a range of 1 mm. With iodine they exceed 2 mm. With nitrogen they do not reach 0·1 mm. The theoretical bearing of these results is discussed. A. B. W.

2450. *Fluorescence and Coloration of Glass Produced by β-Rays.* **J. R. Clarke.** (Phil. Mag. 45. pp. 735–736, April, 1923.)—Experiments are briefly described in which various soda-lime-silica glasses are subjected to the action of β-rays, the general effect of which is to produce first a fluorescence and then a brown coloration, the latter phenomenon being accompanied by a disappearance of the fluorescence. On heating, the fluorescence reappears temporarily and the glasses become decolorised. The times taken by various glasses to pass through these phases at various temperatures are noted. The results point to a similar conclusion to that arrived at by J. Ewles after investigations of the fluorescence produced in various substances by kathode rays, *viz.* that the fluorescence is due to a change in the state of molecular aggregation of the substances.

A. B. C. L.

2451. *The β-Ray Spectrum of UX_1 and its Interpretation.* **L. Meitner.** (Zeits. f. Physik, 17. 1. pp. 54–66, 1923.)—In a previous paper the author has adduced evidence to show the incorrectness of the view of Ellis that the primary action in radio-active disintegration, with the emission of β-rays, is the emission of definite monochromatic γ-rays, owing to the passage of an electron from one energy level in the nucleus to another. It has long been known that UX ($UX_1 + UX_2$) has a remarkably small γ-radiation. UX has two groups of β-rays, one slow and the other fast, and Fajans and Göhring have proved that the former belong to UX_1 and the latter to UX_2. Baeyer, Hahn, and Meitner showed that the slow group included a weak band (1) with velocity $0 \cdot 59c$, and two fairly strong sharp lines (4) and (3) with velocities $0 \cdot 48c$ and $0 \cdot 52c$. In the present investigation the mean velocity of the band was found to be $0 \cdot 581c$, and a third weak line (2) was observed, with velocity $0 \cdot 529c$. The energy differences of (2), (3), and (4) indicate that they originate, respectively, in the N, M, and L levels of UX_1. Since UX_1 is an isotope of thorium, the energy of separation from these levels is to be calculated from that of thorium; adding these three separation energies to the respective kinetic energies of the β-rays, the three sums are nearly identical, which shows that three emissions are produced by the same original radiation acting on the electrons of the L, M, and N layers. Not only this, but this total energy agrees with that of the K_α radiation of thorium, lying between that for the $K_{\alpha 1}$ and the $K_{\alpha 2}$ lines; so that it is concluded that the three sharp β groups originate in the throwing out of electrons by K_α radiations. It seems probable that the K_α radiations are produced by the action of the β-rays, which form the faint band (1); the middle of this band corresponds to an electron energy of $1 \cdot 84 \times 10^{-7}$ ergs, while the work required to separate an electron from the K level of thorium is about $1 \cdot 736 \times 10^{-7}$ ergs. These *primary* nuclear β-rays will thus throw out the K electrons with a small velocity and the K_α γ-radiation will be excited. The fact that the primary β-rays are thus absorbed accounts for the faintness of the band they produce. An examination of the γ-radiation made by the author, in collaboration with O. Hahn, shows that the γ-radiation of UX_1 is really identical with the K_α radiation of thorium, and that no penetrating γ-radiation originates in the nucleus.

H. N. A.

2452. *The Excitation of Secondary β-Radiation by γ-Rays.* **H. Prelinger.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 6. pp. 279–292, 1921.)—The author describes experiments for determining the quality of the secondary β-rays, or electronic radiation, produced in metals by

the hard γ-rays of Ra(B + C); it is attempted to show that the two main components of the γ-radiation produce two different types of secondary radiation. The "true asymmetry coefficients" of these two types of β-rays are calculated; the harder type shows the greatest asymmetry, that is to say the ratio of the β-rays passing out of the plate, in the direction of the original γ-rays, to the β-rays coming out from the other side of the plate, is large. The absorption coefficients of the β-radiation are found to be the same as those of the primary β-radiation of Ra(B + C). The wave-lengths or "widths of impulse" of the γ-radiations are about 3×10^{-10} and 8×10^{-10} cm. It appears probable that each absorbed γ impulse corresponds to a single secondary electron.
H. N. A.

2453. *Absorption and Effective Range of the β-Rays from Radium E.* **A. V. Douglas.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 113–124, 1922.)—The loss of intensity, when the β-rays are passed through different thicknesses of absorbing material, does not follow the exponential law. The loss is brought about by the particle being slowed down or stopped, the energy probably producing ionisation and possibly to a small extent X-rays; the particles are also scattered by collision with the atoms of the absorbing material; the scattering loss is greater the less the velocity of the particles. In the author's experiments the β-rays fell on a plate of absorbing material, and those scattered through approximately 160° to 180° passed backward to the electroscope, which was placed behind, and shielded from, the direct rays of the RaE preparation. Corrections were made for γ-rays, and for air scattering. The results point to the fact that the scattered rays have a range only slightly less than the primary rays, an upper limit for the loss of energy being 10 to 12 %, while this neglects absorption in the radiator, and the fact that the slow β-rays are more likely to be scattered backward than the fast ones. From theoretical considerations it appears that 10,000 collisions with absorbing lead atoms would be necessary to produce a loss of energy of 10 %; and it is concluded that the loss on scattering through 180° is less than this, and possibly zero; this indicates that γ- or "X-rays" are not produced. The effective range of the β-rays was measured in different metals, and plotted against their atomic numbers; it is found to decrease with increase of Z; evidence is given that the actual range, which includes the zigzag path through the absorbing material, increases with the increase of atomic number.
H. N. A.

2454. *Primary and Secondary β-Rays.* **J. A. Gray.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 125–128, 1922.)—The following arrangement was used as a source of "X-rays"; a strong preparation of radium (D + E) was placed between two plates of lead 0·1 mm. thick, and the lead was covered, above and below, by plates of graphite 3 mm. thick; the primary β-rays produce X-rays, often spoken of as γ-rays, though this name may be reserved for the direct products of radioactive disintegration, and these form about 80 % of the noncorpuscular rays passing out, the remaining rays being γ-rays from radium D. The graphite absorbs the primary β-rays which get through the lead. This arrangement was placed below the electroscope, and above it was a lead plate, in which the noncorpuscular rays produced secondary β-rays;

a varying number of absorbing sheets of paper (1 to 30) was placed above this, and the intensity of the β-rays measured. This was corrected for the X- and γ-rays, which passed through the paper (a practically constant amount). It is proved that a very large percentage of the secondary β-rays have smaller velocities than the primary β-rays, which produce the X-rays causing them; a rough estimate makes the average energy 30 % of the original energy. A primary β-ray loses energy before it has a chance of exciting X-rays, and when this takes place the whole of the energy may not be given up as an X-ray. These results prove that secondary β-rays, after ejection from the parent atom, can play little part in the production of the penetrating secondary X-rays [see next abstract] which are always found in any substance struck by a beam of (primary) X-rays. A beam of X-rays of frequency ν will eject β-rays, giving a quantum of energy $h\nu$ to each electron; these will excite soft secondary X-rays, of frequency much less than ν, since the above experiments show that such X-rays eject secondary β-rays, with energy much less than $h\nu$. The penetrating secondary X-rays mentioned above have frequencies which, though lower than that of the primary, are of the same order, and they cannot be produced by the secondary β-rays. Ultimately any beam of X-rays, passing through matter, will be transformed into β-rays, by alternate changes from X to β, back to softer X, and so on. H. N. A.

2455. *The Softening Exhibited by Secondary X-Rays.* **J. A. Gray.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 129–134, 1922.)—In this paper the term secondary X-rays has no reference to ordinary characteristic radiations; but is confined to those rays which are given off in all directions from a radiator struck by a beam of "primary" X-rays, the quality or frequency depending on that of the primary rays, and being independent, for radiators of small atomic weight, of the nature of the radiator. Nearly monochromatic X-rays struck a cylindrical block of paraffin wax, and the electroscope was placed so that it pointed towards the cylinder, the joining line making an angle with the beam incident on the cylinder. Secondary X-rays from the cylinder entered the electroscope chamber. An absorption plate, usually of aluminium, was placed, first in the beam of primary X-rays, and then in the secondary beam. If the frequency were the same in both cases the two readings would be the same; but this is not the case, since the secondary rays, being softer, are absorbed to a greater extent than the primary. Similar results were obtained with aluminium and water radiators. An interesting variation of the experiment was made by using a silver plate as absorber. The mass absorption coefficient of the primary rays in silver was 17·6 and that of the secondary rays 12·8, so that the whole phenomenon was reversed, and the ratio of the electrometer readings was 0·57, instead of being greater than unity, as it was before. Further experiments led to the conclusion that the softening of secondary X-rays is not due to their being formed by secondary β-rays, and that every electron which the primary X-ray beam may influence in passing plays a part in the phenomenon. H. N. A.

HEAT.

2456. *Vapour Pressure Thermometer.* **A. Stock.** (Zeits. Elektrochem. **29.** pp. 354–358, Aug. 1, 1923. Paper read before the Deut. Bunsen-Gesell., Hanover, May, 1923.)—This paper gives a description of a vapour pressure thermometer suitable for use at low temperatures. The method of setting up the instrument is described, the liquids employed for the various ranges being SO_2, – 10° to – 40°; NH_3, – 30° to – 77°; CO_2, – 75° to – 100°; HCl, – 85° to – 110°; C_2H_4, – 100° to – 150°; CH_4 – 150° to – 180°, O, – 180° to – 200°. The paper contains a table of recent determinations of the vapour pressures [Abstract 1800 (1921)] of these substances at various temperatures. The thermometer possesses distinct advantages over liquid in glass or electrical thermometers for these ranges. Temperatures can be determined with ease to an accuracy of $\frac{1}{10}$°. The design of the instrument is such that only a small quantity of mercury is employed, total pressures are read directly and there is complete isolation from the external atmosphere. L. L.

2457. *Vapour Tension of Mixtures of Hydrochloric Acid and Water.* **N. Yannakis.** (Comptes Rendus, **177.** pp. 174–175, July 16, 1923.)—Records results of the measurements of the vapour pressure of mixtures of HCl and water at 50° C., boiling at this temperature being produced by adjusting pressure.

Per cent. HCl in solution	0	6·6	10·3	13·1	17·1	19·1	19·2	22·8	23·6	25·1	28·7
Per cent. HCl in vapour	0	0·07	0·17	0·34	2·4	4·5	5·3	18·6	23·1	35·6	87·3
Pressure in mm. of mercury	92	81	75·5	71	63	59	58	53	52·5	54	85

L. L.

2458. *Saturated Fluids near the Critical Point.* **E. Ariès.** (J. de Physique et le Radium, **4.** p. 152, April, 1923.)—Errata to the paper referred to in Abstracts 931 and 1418 (1923).

2459. *Liquefaction of Hydrogen and Helium. Part II.* **J. C. McLennan** and **G. M. Shrum.** (Roy. Soc. Canada, Trans. **16.** Sect. 3. pp. 181–193, 1922.)—Description of apparatus for the liquefaction of hydrogen which is an improvement on that described in Abstract 1151 (1922). The aim was to obtain high efficiency in operation, not simplicity. The paper deals with the following constructional details:

Compressors and Gasometers.—A four-stage compressor with special stuffing-boxes in which the packing is sealed with oil holders, is used in the hydrogen circuit. For the helium circuit a two-stage compressor with completed enclosed crank-case, is used with special packing glands. The gas-holders float on oil and are counterpoised.

Purification of the Hydrogen.—The hydrogen is purified by passing through a high-pressure bomb filled with palladiumised asbestos heated to about 350° C. This process reduces the oxygen to less than 0·1 per cent. As a trace of impurity ultimately chokes the expansion coil, the arrangement described by Onnes is used for obtaining absolutely pure hydrogen.

Hydrogen Liquefier.—The construction of this is similar to that described in the first paper.

Helium and its Purification.—The helium was obtained from the natural gas of the Bow Island district. The 90 per cent. helium is to be purified before use in these experiments by condensation when cooled in liquid air, absorption by means of cocoanut charcoal, absorption with CuO or by burning with oxygen in the presence of palladiumised asbestos.

Helium Liquefier.—This is the same in general form as that of Onnes.
E. G.

2460. *High-Temperature Investigation.* **E. F. Northrup.** (Frank. Inst., J. 195. pp. 665–686, May, 1923.)—A general review of the properties of matter at different temperatures and an account of high-frequency induction furnaces. A description of these furnaces has already been published [see Abstract 778 (1923)]. E. G.

2461. *An Experimental Method of Determining the Relative Effects of Radiation and Convection in Still or Moving Air, on the Change in Temperature of a Body in a Given Situation.* **L. H. Nichols.** (Roy. Soc. Canada, Trans. 16. Sect. 3. p. 333, 1922.)—The rates of cooling of two large alcohol thermometers, one of which has its bulb silvered and polished, are observed under the conditions to be tested. Combining these with the rates of cooling of the unsilvered thermometer when enclosed in a high vacuum and in still air surrounded by an enclosure at the given temperature, the relative effects of radiation and convection are determined. A. W. L.

2462. *The Use of Smoked Glasses in Optical Pyrometrical Measurements.* **F. Hoffmann.** (Zeits. f. Physik, 17. 1. pp. 1–22, 1923. From the Reichsanstalt.)—In order to extend the range of optical pyrometers, smoked glasses and absorbing screens are used. The theory of the use of such devices is simple in the case of monochromatic light and may be expressed by the relation $-\log V = \log H/H' = M.C(1/T' - 1/T)/\lambda$ which follows from Wien's radiation law. Here H, T denote the brightness and temperature of the source, H′, T′ the same with screening. H/H′ may be termed the permeability of the screening device, and C is the radiation constant, = 14,300, while M = 0·4343, the logarithmic modulus. The equation shows that for monochromatic light, $1/T' - 1/T \equiv \tau$, the "pyrometric weakening" is constant, *i.e.* independent of the temperature. In practice the light is not monochromatic, but corresponds to a finite strip of the spectrum, and we have to determine the effect of smoked glasses and absorbing screens on the accuracy with which the temperature of the source may be deduced. The author works out the corrections in the case of the two Jena smoked glasses Nos. F3815 and F7839 in combination with the Jena red filter F4512 when used in the Holborn-Kurlbaum pyrometer. Two methods are given of making the calculation, based on the idea of "effective wave-length" employed at the Reichsanstalt since 1910. The glass F3815 shows an increase of 1·5 % in the value of τ with increasing temperature, while the glass F7839 shows a constant value. The change in the value of τ is seen to be essentially determined by two factors, *i.e.* (1) by the shift of the effective wave-length in consequence of the selective permeability of the smoked glasses; (2) by the change of wave-length of the weakened light relatively to the unweakened in consequence of the different spectral composition of the modified higher radiation. There is also to be taken into account the change of wave-length of both radiations in consequence of a change of temperature of the source. The first factor causes a change of τ, the direction of which depends on the direction in which the effective wave-length of the filter is shifted by the introduction of the smoked glass. In both glasses examined an increase in τ with increasing temperature corresponded to an increase of permeability towards the red for both glasses. The second factor causes a decrease in τ with increasing temperature. These factors tend to compensate each other, and in the case of glass F7839 the compensation is by chance exact. The pyrometric weakening due to a rotating sector is also calculated. T. B.

2463. *Effects of Carbon and Strain on the Specific Heat of Carbon Steels.* **K. Honda.** (Japanese Journ. Phys. 1. 7–8. pp. 71–84, 1922. In English.) —An investigation to find why the linear relation between the specific heat and the carbon content fails. The arrangement was that used by Tadokoro [Abstract 588 (1922)], the specific heat being determined by the method of mixture. As a control, the specific heat of silver was determined; 0·0561, the value found, agrees with previous determinations. Fourteen steels with carbon varying from 0·10 to 1·48 per cent. were tested before annealing; the specific heat for the range 20°–150° C. varied from 0·1126 for electrolytic iron to 0·1233 for 1·48 carbon steel, giving on a carbon-specific heat graph two straight lines which meet at a concentration of 0·9 per cent. carbon. This agrees with Meuthen's results. The specimens were next annealed at 650° for 24 hours, and on measuring their specific heats again, it was found that the break at 0·9 per cent. carbon had disappeared; this effect had been found by Levin and Schottky. Meuthen's effect is thus shown to be due to lack of annealing. The specific heat of cementite is next found; two cast irons of high carbon content were tested, and graphed along with the steels, and by extrapolation the value 0·151 is found for cementite. The cause of the decrease in the specific heat of forged specimens due to prolonged annealing was next investigated and is found to be due partly to the release of strain and partly to the decomposition of cementite present in the steels. The true specific heat of a steel is that found for it in the normalised state. G. E. A.

2464. *Maxwell's Distribution Law.* **A. Wassmuth.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 3–4. pp. 159–166, 1921.)—For a large number of degrees of freedom of a system of n-particles, Boltzmann and Gibbs express this equation in the form $S_n = \log V_n$ where S_n is the entropy of the system and V_n is the corresponding phase volume representing a canonical distribution. The author here gives a simpler and shorter method of establishing the general equation, with a series of examples of the application of his method to special cases. G. W. DE T.

2465. *An Imaginary Thermodynamic Process.* **J. S. Ames.** (Frank. Inst., J. 195. pp. 655–663, May, 1923.)—The paper is a description of the method of teaching adopted by the author to give the student a definite conception of "entropy." The original must be consulted, as the paper is unsuitable for a brief abstract. E. G.

2466. *The Thermal Constants of Condensed Hydrogen.* **F. Simon** and **F. Lange.** (Zeits. f. Physik, 15. 6. pp. 312–321, 1923.)—The physical properties of substances become simpler at very low temperatures. Such measurements are of interest, since the energy relations at low temperatures are required in application of Nernst's heat theorem and of Debye's T^3 law which permits extrapolation down to absolute zero. The authors have been able to work down to 9° abs. with liquid hydrogen, thus obviating the use of liquid helium which is unobtainable in most laboratories. The essential parts of the apparatus, which is entirely of metal, consist of a small copper calorimeter holding about 60 c.c. and weighing 8 gm. This is connected by a thin german silver tube to the external parts of the apparatus. The calorimeter is surrounded at a distance of 1 cm. by a copper vessel, which is connected to a mercury pump. A Dewar flask containing liquid H is slipped over the copper vessel, the latter having been evacuated and cooled with liquid air. The calorimeter is now connected with a "balloon" containing H. When the pressure in the Dewar flask is reduced by pumping, the H condenses in the tube and runs into the calorimeter. When sufficient H has been condensed, the pressure is reduced by a mercury pump and charcoal cooled in liquid air. The calorimeter is thus reduced to a temperature of 9° abs. A coil of constantan wire of resistance 3000 ω is placed in the calorimeter and serves as the heating coil, the temperature being determined from the vapour pressure of the H, this being measured when very low by a McLeod gauge. The specific heats, etc., can thus be determined by observing the amount of heat necessary to raise the temperature by a given increment. In the determination of the specific heat of solid H, the temperature of the Dewar flask was kept at the triple point. The temperatures were calculated from the observed pressures by the formulæ—

$$\log p \text{ liquid} = -44{\cdot}368/T + 3{\cdot}5328 + 0{\cdot}03240T - 0{\cdot}0004189T^2 + 0{\cdot}00000484T^3.$$

$$\log p \text{ solid} = -40{\cdot}123/T + 2{\cdot}5 \log T - \int_0^T E(\text{Debye } 91)\,dT/4{\cdot}571T^2 + 5{\cdot}30 \,.\, 10^{-10}T^6 + 3{\cdot}67 \,.\, 10^{-11}T^7 + 0{\cdot}7700.$$

The molecular heats for solid and liquid H are tabulated. The latent heat of solid H was deduced by heating at temperatures a little above and a little below that of the triple point. A comparison of the author's results with those of Keesom and Eucken is given. The final results are: (1) The molar heat of solid H can be represented by a Debye function $\beta V = 91$ with an error of $\pm 1{\cdot}5\,\%$; (2) the molar heat of liquid H between 15° and 19° abs. is $0{\cdot}33 + 0{\cdot}206\,T$, error $\pm 1{\cdot}5\,\%$; (3) the molar latent heat of solid H is $28{\cdot}0 \pm 0{\cdot}1$ cal.; (4) the molar heat of evaporation between 14° and 20° abs. is $219{\cdot}7 - 0{\cdot}27(T-16{\cdot}6)^2$ cal., error $\pm 1{\cdot}1$ cal.

T. B.

2467. *The Chemical Constant of Hydrogen.* **F. Simon.** (Zeits. f. Physik, 15. 6. pp. 307–311, 1923.)—The chemical constant of hydrogen was determined in 1914 by Kohner and Winternitz from the equation $Hg + H_2O = HgO + H_2$, the value obtained being $-1{\cdot}23 \pm 0{\cdot}15$, and in 1921 by van de Sande Bakhuyzen, who obtained $-1{\cdot}11$, which is very near the theoretical value $-1{\cdot}13$. This value, however, is accidental on account of errors of calculation. The author in conjunction with F. Lange has recently [see preceding abstract] determined the thermal constants for condensed hydrogen and is hence in a position to calculate satisfactorily the chemical constant of hydrogen. From the latent heat of evaporation of solid H at the triple point, and the specific heats of the gas and solid, the author calculates $d \,.\, \log p/dT$. The known pressure at the triple point then allows the determination of the constant to be made. Writing the Clausius-Clapeyron equation in the form $d \,.\log p/d\mathrm{T} = (\lambda/\mathrm{RT}^2)(\mathrm{RT}/p\mathrm{V})$, and making use of the calculated values of λ and p, this becomes on integration and introduction of common logarithms,

$$\log p = -183\cdot4/4\cdot571\mathrm{T} + 5\log\mathrm{T}/2 - (1/4\cdot571)\int_0^{\mathrm{T}}\mathrm{E}(91)d\mathrm{T}/\mathrm{T}^2$$
$$+ 5\cdot30\,.\,10^{-10}\mathrm{T}^6 + 3\cdot67\,.\,10^{-11}\mathrm{T}^7 + \mathrm{C},$$

and substituting the numerical values at the triple point $\mathrm{C} = -1\cdot11$ and $\mathrm{C}_0 = -1\cdot56_7$, compared with the theoretical value $\mathrm{C}_0 = -1\cdot588$ (Nernst, Theor. Chemie, 8–10. p. 807). Introducing the value of C, the author calculates and tabulates the values of the vapour pressure of solid H between the temperatures of 7·0° T and 13·94 T. T. B.

2468. *The Equation of State of Liquid and Vapour Forms of Water.* **O. Tumlirz.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 3–4. pp. 93–133, 1921.)—The author for several years attempted to obtain an equation of state for water which would give the properties of the liquid and vapour forms. He first obtains from theoretical considerations a mechanical picture, and then extends this by the evaluation of arbitrary functions in an empirical manner. The theoretical methods employed at the outset are the same as used previously [see Abstract 556 (1903)]. Starting with the energy equation $d\mathrm{U} = d\mathrm{Q} - pdv$ and putting in the condition for a reversible change of state at constant temperature, this becomes $d\mathrm{U} = -[\mathrm{T}(\partial v/\partial\mathrm{T})_p + p(\partial v/\partial p)_{\mathrm{T}}]dp$. If further the body is of such a nature that the heat supplied from without is equal to the external work done, we have $d\mathrm{Q} = pdv$ and $d\mathrm{U} = 0$; $\therefore\ \mathrm{T}(\partial v/\partial\mathrm{T})_p + p(\partial v/\partial p)_{\mathrm{T}} = 0$, which is characteristic of a perfect gas. Integrating we have $v = \mathrm{F}(\mathrm{T}/p)$, or $\mathrm{T}/p = \mathrm{G}(v)$, or $p = \mathrm{T}/\mathrm{G}(v)$. When v is very large $\mathrm{G}(v) = v/\mathrm{R}$. A correction is now applied for the attractive force between the molecules. Calling P the cohesion pressure, the above equation becomes $p + \mathrm{P} = \mathrm{T}/\mathrm{G}(v)$, from which van der Waals' equation, $p + a/v^2 = \mathrm{RT}/(v - b)$, easily follows; but as this does not agree with experiment Clausius writes it $p + \theta(\mathrm{T})/(v + \beta)^2 = \mathrm{RT}/(v - b)$, where β is a positive constant and $\theta(\mathrm{T})$ a function of the temperature. In order to make the equation hold for liquid as well as vapour, *i.e.* in order to take account of association in the liquid form, it is assumed that the attraction between two mass elements ρdv and $\rho dv'$ is given by $\rho dv\,.\,\rho dv'\,.\,f(\rho, \mathrm{T})\,.\,\phi(r, \mathrm{T})$, whence the cohesion pressure $\mathrm{P} = \rho^2 f(\rho, \mathrm{T})\,.\,2\pi\chi(\mathrm{O}, \mathrm{T})$, where $\int_r^\infty \phi(r, \mathrm{T})dr = \psi(r, \mathrm{T})$ and $\int_r^\infty r^2\psi(r, \mathrm{T})dr = \chi(r, \mathrm{T})$. The equation of state then becomes

$$p + \rho^2\theta(\mathrm{T})\,.\,f(\rho, \mathrm{T}) = \mathrm{T}/\mathrm{G}(v),$$

and we have to determine the functions $\theta(\mathrm{T})$, $f(\rho, \mathrm{T})$, and $\mathrm{G}(v)$ so that the equation represents the results of observation for all liquid and gaseous forms. This proves very difficult, especially in the case of $f(\rho, \mathrm{T})$ which the author writes in the form $(i - \eta)/(i + \eta)$, where η is a long and complicated expression. Tables are given showing a comparison between calculated and observed values of many experimentalists, including Amagat, Bridgman, Battelli, Knoblauch, Linde, and Klebe. The paper concludes with some observations on the maximum density of water and the critical constants. T. B.

SOUND.

2469. *Mechanical Devices for Demonstration of Vibrations of Strings and Springs.* **S. Hayashi.** (Kyoto Coll. Sci., Mem. 6. pp. 165–169, March, 1923. In English.)—Describes a number of devices. The first is an adjustable " buzzer " and produces notes of various frequencies up to 5000 per sec. The second produces Lissajous' figures. The third deals with struck strings operated by a special hammer. The reproductions of photographs of the motions of hammer and string seem to confirm Kaufmann's theory that the string's vibrations start as soon as the hammer leaves the string. Ten excellent photographic reproductions accompany the paper. E. H. B.

2470. *Cavitation in the Propagation of Sound.* **R. W. Boyle.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 157–161, 1922.)—In the theory of the radiation of sound waves from a diaphragm or plate into a fluid medium, and also of the propagation of the waves through the medium, there enters a question as to whether the maximum amount of energy which can be transmitted is, or is not, limited by the phenomenon of cavitation. Thus, when a diaphragm moves outward it sends a compressional wave in the medium. But, when the diaphragm springs back, can the medium always *immediately* follow back with it, or does it sometimes leave a partial vacuum or *cavity*, thus interrupting the rhythmic motion of the wave ? If the normal pressure is p_0, and the maximum change due to the wave is $\pm p$, then the resultant pressures will be $p_0 \pm p$. And, to avoid tension this must not be negative. Calculations now follow, from which it is concluded that there is no possibility of cavitation being encountered in the transmission of sound waves in air. For liquids, on the other hand, it is found that the transmission of sound might involve a limitation of the power of transmission through cavitation. Further experiments as to how much sound energy can be imparted to water are still needed in spite of the work of King and of Fessenden.

E. H. B.

2471. *Acoustic Constants of Cloth.* **K. Kurokawa.** (Inst. El. Eng. Japan, J. No. 415. pp. 113–141, Feb., 1923. In English.)—This paper describes a new method for measuring the acoustic constants of cloth, namely, what is here called the *surge impedance density*, and the attenuation constant. These characteristic constants lead to the computation of the speed of propagation of sound, and the coefficients of reflection and transmission at a transition surface between that material and air. The apparatus employed includes a tube with telephone diaphragm at one end and the test piece or pieces of cloth across the tube. The telephone receiver is included in a Wheatstone bridge for testing purposes. The details of the arrangement are shown in a number of diagrams and many graphs are given of the results of various tests. The paper concludes with a bibliography of 38 references. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2472. *Atmospheric Electricity.* **K. Kähler.** (Meteorolog. Zeits. 40. pp. 204–211, July, 1923.)—The space charge of air, from a height of 1 m., was measured at Potsdam over a period of one year. The diurnal variation was regular; highest during the night and lowest in the afternoon. It was always positive, and the effect of sunlight was to reduce the value. Generally speaking, the space charge varied parallel with the potential. These conclusions apply to dry-weather conditions. In gentle rain the space charge decreased with the amount of the rain, but in stormy weather and during rapid changes it might rise considerably [see Abstract 1682 (1922)]. W. A. R.

2473. *The Potential Drop in a Plate Condenser, as Influenced by Ionisation due to α-Rays.* **M. Artner.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 6. pp. 253–264, 1921.)—The potential drop in a plate condenser, ionised with polonium, was investigated, and it was found that, when the distance between the plates was increased, the potential gradient near the active plate became constantly smaller, and so the assumption that, under the same conditions, the diminution of the current is governed by the diminution of the potential difference is confirmed. Experiments, in which the strength of the polonium preparation were varied, show that with increasing ionisation the curves vary from the normal potential distribution, and it was found that with constant plate distance, constant mean voltage drop, and sufficiently high strength of preparation, the curves approach a limiting position. Surface ionisation, which can only be approximately attained by variation of the plate distance and preparation strength, can be completely produced by altering the potential difference between the plates. If the alteration in the form of the curves, with a given preparation and constant plate distance, is observed when the mean rate of voltage drop is varied, they are found to vary in a complicated manner between two boundary positions; the lower boundary runs as a straight line from zero potential at the end of the range up to the full voltage at the inactive plate; throughout the range the potential is the same (zero). Surface ionisation is then attained, and continues for lower potential differences. The range of the α-rays affects the form of the potential curve; with small voltage difference the range can be approximately determined from the voltage curve. In many of the observations a probe electrode was used, the point of which was activated with polonium, the range of the α-rays from which was reduced by depositing on it a layer of copper electrolytically, so that they should not disturb the field between the plates. H. N. A.

DISCHARGE AND OSCILLATIONS.

2474. *On the Transformations of Hydrogen Canal Rays.* **E. Rüchardt.** (Ann. d. Physik, 71. 6. pp. 377–423, June 14, 1923.)—Experiments in which canal rays have traversed two magnet fields consecutively, show that in the canal ray the charge condition exhibits a kinetic equilibrium whereby transformations take place between the gas molecules and the canal-ray particles. Wien's theoretical considerations, involving the conception of an average free path, have not received altogether satisfactory confirmation from the experiments of Königsberger and Kutschewski [see Abstract 905 (1912)] and further experimental work is required. The present investigation relates to the hitherto uncertain influences of gas pressure and ray velocity on the transformations, and is concerned with the changes of hydrogen canal rays in different gases. The earlier sections of the paper deal with theory and method; experimental details and tables of data being included. Following this comes a description of measurements with homogeneous hydrogen atom rays in hydrogen. Rüttenauer's work is often referred to, and a section is devoted to a comparative criticism of his results. Experiments on identical lines are then described for nitrogen and oxygen. Vegard's work is also discussed in connection with the pressure results now obtained. The paper, however, is mainly mathematical, and further work is needed before definite conclusions can be drawn. H. H. Ho.

2475. *The Normal Kathode Fall at Graphite in Gas Mixtures.* **A. Günther-Schulze.** (Zeits. Elektrochem. 29. pp. 370–373, Aug 1, 1923. Paper read before the Deut. Bunsen-Gesell., Hanover, May, 1923.)—This investigation of the normal kathode fall in mixtures of two gases was carried out to acquire further data for the still tentative theory of the kathode fall, and also to ascertain the influence of foreign gases on this effect. Graphite was employed to avoid combination of the kathode material with the surface layer, and full experimental details with curves are given of the method employed. It was found that the kathode fall at graphite in air was increased from 339 to 361 volts by preliminary gas removal from the kathode, while it remained unchanged in mercury-vapour. The kathode fall in mixtures of Hg–Ar follows exactly the simple arithmetic mixture law, but is lower for the mixtures H–Ar and O–CO and higher for the mixtures Hg–O, Hg–CO, Hg–H, Hg–N, O–Ar, O–H, O–N. A great sensitiveness towards impurities is exhibited by Hg for O and CO, H for O and Hg, and N for O and Hg. The following average values for the kathode fall at graphite were obtained: Hg 452 V, O 371 V, CO 394 V, Ar 158 V, H 223 V. H. H. Ho.

2476. *Remark on Günther-Schulze's Paper Dealing with the Energy Relations at the Kathode in Glow Discharge.* **R. Seeliger.** (Zeits. f. Physik, 16. 3. pp. 211–215, 1923.)—While the measurements of the energy imparted to the kathode in Günther-Schulze's experiments are valuable, his theoretical deductions, if correct, would prove the foundations of all previous considerations of the relations in the kathode dark space to be erroneous. It appears, however, that he has made use of incorrect assumptions as to the kinetics of the positive ions. All experience with canal rays shows that, apart from the fact that they are not all positively charged, but in part are neutral particles, they do not behave at all like elastic spheres, to which the geometrical laws of mechanical collision can be applied. The particles as a rule suffer very small loss of velocity, and are only slightly deviated, in collisions in which their charge is altered; and are absorbed without much previous loss of velocity when an absorbing collision takes place. Besides this, it is only for the first type of collision that the free path is of the same order as the molecular free path, for the second it is very much greater. For velocities of the ions which correspond to higher, anomalous kathode drop, these properties of the canal rays can be made use of directly and quantitatively; for small velocities, corresponding to normal kathode fall, similar complete observational material is not available, but qualitative observations (*e.g.* those of Dempster) indicate that the state of affairs is not different in this case. In any case what is known of the kinetics of canal rays appears to agree with the results of Günther-Schulze, without any assumption of high temperature in the dark space. Experiments are mentioned which are regarded as proving that the actual temperature in the dark space is, in general, low; the rise of temperature in one case, with three times the normal current-density, being estimated as 80° C. [See Abstract 1926 (1923).] H. N. A.

2477. *Electrodeless Discharge in Iodine and in Hydrogen.* **J. K. Robertson.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 151–155, 1922.)—The author has elsewhere [see Abstract 1897 (1922)] given results of a spectroscopic study of the discharge excited in certain vapours by electromagnetic induction. In the case of iodine, the only diatomic vapour studied, it was found that, as the electrical excitation was gradually increased, a stage was reached at which a sudden and marked change in the character of the discharge took place. It seemed desirable, therefore, to extend the investigation to other diatomic gases and vapours, and especially to hydrogen, whose complex secondary spectrum still awaits a satisfactory explanation. The experimental arrangement, which is described, differed little from that first used by J. J. Thomson. The results obtained with iodine are briefly referred to, and then those obtained with hydrogen are discussed. In these hydrogen experiments every precaution is taken to use only pure dry gas, and the method employed to secure this is briefly described. From the experiments described it would seem that in pure hydrogen four distinctly different coloured discharges are possible: (1) *Whitish*, in which the Balmer lines are almost absent; (2) *pink*, in which both line and secondary spectra are strongly developed; (3) *red*, in which H_α and H_β are relatively very strong and at least a portion of the secondary is absent; (4) *blue*, in which, according to Masson, the secondary is entirely absent and, moreover, H_β is stronger than H_α. Certain phenomena observed are still awaiting satisfactory explanation, as, for example, the appearance of the red discharge, which is evidence of an excess of atomic hydrogen, on the inner portion of the ring. A plate giving the pink and red spectra is included. A. E. G.

2478. *Surface Ionisation.* **M. Hornyak.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 3–4. pp. 135–147, 1921.)—The effect of varying plate distance on the form of the field in a plate condenser was examined, and it was shown that with 11 cm. distance it was sufficiently uniform. An experiment was made which showed that the form of the current voltage curve was not essentially influenced by ionic air currents. In an attempt to produce surface ionisation the distance between the plates was varied, with fixed range for the α-particles, and the relation between the form of the curves for current and ratio between range and plate distance was studied. The curves only agreed with Rutherford's theoretical curves up to about 4 volt/cm. If the ionisation is not strong enough one of the conditions of the theory, namely the knowledge of the form of the electrical field, is not available. The mobility of the positive and negative ions was calculated from the results of the experiments, and it was found that, from a plate distance almost five times the range upwards, with a polonium preparation screened down to give an external range of 1·4 cm., and having a strength of about 68 e.s.u., values agreeing with those obtained by other methods were given with potential differences between 10 and 15 volts. With a preparation of half this strength the values are too small; and, with voltages higher than 15, the assumption that the potential gradient at the ionised plate is zero, as required by Rutherford's theory, no longer holds. The diameter of the condenser plates was 20 cm. H. N. A.

2479. *Properties of Tungsten Filaments.* **F. Wolfers.** (Radioélectricité (Bull. Technique), 4. pp. 10–14, June 15, and pp. 22–24, July 15, 1923.)—After a discussion of photometric and of electric methods of determining the temperature of an incandescent tungsten filament, results obtained by Langmuir, Worthing, Stead, and Dushman are discussed with reference to the design of filaments for particular purposes. A. W.

2480. *On the Photoelectric Distribution of Velocity.* **O. Klemperer.** (Zeits. f. Physik, 16. 4. pp. 280–299, 1923.)—The photoelectric distribution of velocity, *i.e.* the relative frequency with which the different values of the velocity are represented in the electronic emission produced by monochromatic light, may be determined by two methods, *viz.* (1) in which the emitted electrons are subjected to a retarding electric field and the electronic stream from the illumined electrode measured as a function of the strength of this field; (2) in which the emitted electrons are deflected by a homogeneous magnetic field perpendicular to their direction of motion, and so form circular orbits whose radii are directly proportional to their velocities and inversely to the strength of the applied field. The first method has been worked out by Lenard and used by numerous other workers, *e.g.* Millikan [see Abstract 713 (1916)], Hennings, and Kadesch [see Abstract 1269 (1916)], who found a definite maximum velocity to obtain. The magnetic method, however, has hitherto only been used by Ramsauer, who in contrast to Millikan obtained with increasing velocities a gradual asymptotic approximation of the curve to the velocity axis, and therefore disputed, the occurrence of a maximum velocity. Millikan opined that Ramsauer's results are to be explained by the insufficient spectral purity of his activating light. The question of a maximum velocity is of importance for the theory of the photoelectric effect, and such is to be expected on the quantum theory, while an asymptotic curve demands an alternative theoretical explanation. In the present paper it is experimentally shown that Ramsauer's measurements are disturbed to a considerable degree by electronic reflections, and that thereby the asymptotic fall in his curves is accounted for. Experimental details are given for methods employing an opposed e.m.f. and also utilising the magnetic procedure, both being carried out in the same apparatus. A well-defined maximum velocity is found to exist, but the number of electrons of high velocity is relatively very small. The opposed e.m.f. method leads falsely to a steep end decline of the velocity distribution curve if the receiving electrode is somewhat photoelectrically active. The curves from the magnetic method are disturbed in the parts of weak energy by the influence of electronic reflection, and it is impossible to draw conclusions from them as to the existence of a maximum velocity. The photoelectric distribution of velocity experiences a very definite change by the ageing of the surface, in which the relative frequency of the smaller velocities decreases quicker than that of the greater. H. H. Ho.

2481. *The Quantum Equivalent in Photoelectric Conduction.* **B. Gudden** and **R. Pohl.** (Zeits. f. Physik, 17. 4-5. pp. 331-346, 1923.)—The energy as well as the number of electrons liberated in the photoelectric action on solid and liquid bodies depends on the frequency of the light. The energy attains as its maximum the Planck quantum $h\nu$ for frequency ν, and Einstein [see Abstract 1562 (1905)] has established its enigmatic independence of the light intensity, a result supported by numerous experimental investigations. How the number of electrons depends on the light frequency is still obscure, and the value $N = \phi/h\nu$ has been taken for an absorbed light energy Q, although observations afford only 3 % of the quantum equivalent, which may well be due to the as yet obscure surface effects. The present paper supplies further data to establish the quantum equivalent law for photoelectric conduction. The linear frequency dependence of the electronic yield has been found for the diamond to range from 225 to 450 $m\mu$ and for zinc blende from 405 to 489 $m\mu$. For the Planck constant h a value $7 \cdot 10^{-27}$ erg. sec. has been found. H. H. Ho.

2482. *The Activating Absorption and Extinction of Phosphores.* **E. Rupp.** (Ann. d. Physik, 72. 2. pp. 81-121, July 20, 1923.)—Lenard's pioneering work on this subject [see Abstract 726 (1905)] is first discussed, after which the author investigates a series of phosphores, especially those containing Cu and Bi as active metallic atoms, with respect to the effect of the active wave-lengths of light, and of kathode rays. The distribution of the total light, of the activating absorption, and of the extinction of phosphorescence centres of long duration, has been evaluated in two different ways. The distribution curves obtained for the different phosphores have been referred to absolute wave-lengths by means of dielectric constant measurements. Spatial and temporal fluctuations in the oscillation periods of the phosphorescence centres have been established. The short-wave extinction action has been traced to a photoelectric effect at the genus atom of the phosphore, and this has been evaluated and compared with the results of investigations on the work of separation. For ZnCuα, a causal connection has been derived between extinction and change of dielectric constant during illumination. The general law for the photoelectric effect which has been established is: That for the separation of a photoelectric electron in the medium of dielectric constant ϵ, a smaller amount of energy is necessary than in the ether in the ratio of $\sqrt{\epsilon} : 1$. H. H. Ho.

2483. *The Point Discharge.* **J. Finkelstein-Cukier.** (Ann. d. Physik, 71. 8. pp. 509-536, June 14, 1923.)—Warburg has given for the point discharge an empirical formula of the form $i = \alpha V(V - M)$; in which i = the current V = the potential difference between the point and plate M = the mm. potential, *i.e.* the smallest potential with which the point current can be observed, a = a constant which depends on the form of the point, the nature and pressure of the gases as well as on the distance between the point and plate. Although researches on the point discharge have been carried out on several other gases such as H_2, N_2, O_2, CO_2 as well as on air, it is only in the case of the latter that the Warburg formula has been proved. It therefore appeared of interest to ascertain whether the Warburg simple formula is also valid for other gases than air. The apparatus employed is described with the aid of sketches and photographs showing the appearance of the point before and after discharges of one hour duration of 4000 volts and − 4000 volts are given. The results of the research here described are as follows: The characteristic of the point discharge is dependent on the microscopic form of the point. The characteristic of the positive point discharge for point with clear-cut conical ends can be expressed by the formula $i = c(V - M)(V + b)^2$ where C, M, b, are constants for a certain pressure, gas and point. The production of the light cone enveloping the point increases in a linear manner with the tension. The strengths of the point currents which are measured in stagnant air in closed vessels are not reproducible, on the other hand if air is sucked through the discharge vessel the point currents are reproducible and obey the above given formula. A. E. G.

2484. *Arc Hysteresis Curves.* **S. Murai** and **H. Yagi.** (Inst. El. Eng. of Japan, J. No. 421. pp. 750–758, Aug., 1923.)—Arc hysteresis curves obtained by a Braun tube are reproduced for cases when the series impedance is both non-inductive and inductive. These cases are studied. The hysteresis is considered to be due partly to the energy consumption required for the ionisation at and near the electrodes, and partly to storage of kinetic energy by the ions in the arc flame. W. R. C.

2485. *Electric Sparks. Part I. Spark Retardation.* **P. O. Pedersen.** (Ann. d. Physik, 71. 5. pp. 317–376, June 5, 1923.)—The work on the subject is briefly reviewed, after which the paper is divided up as follows: The method employed is described in detail with diagrams. The spark retardation with clean or active kathodes, the minimum retardation is, within the limits of accuracy of the present researches, found to be the same for kathodes of lead, tin, aluminium, zinc, copper, brass, iron, silver, gold, platinum, nickel, molybdenum, and wolfram. The dependence of the minimum retardation on the air pressure and on the nature of the surrounding gas is next considered. In order to test the effect of dirty kathodes upon the spark retardation, experiments are carried out in which (*a*) the electrodes are defiled with a mixture of benzene and oil, (*b*) moistening the electrodes with a mixture of ether and oil, (*c*) moistening only the kathode, (*d*) moistening only anode, (*e*) defiling both electrodes, (*f*) the influence of ionising the spark path with a radium preparation when using dirty kathodes, (*g*) ionising with the light of an arc lamp placed about 200 mm. from the spark path. The purity or activity of the electrodes is discussed, after which the alterations of the electrode surface caused by the spark itself are dealt with as follows: (*a*) The action of the spark discharges on clean electrodes, (*b*) action of the spark discharge on dirty electrodes. In experiments on the effect of using point electrodes upon spark retardation it is found that with pointed anode the retardation depends only in a slight degree—perhaps not at all—on the form of the kathode. With spherical anode the retardation when using a pointed kathode is only a little smaller than with a spherical kathode. A recapitulation of the results obtained will be given as an introduction to Part II of this communication.

A. E. G.

2486. *Note on a Publication by N. Kapzow on "The Diffraction of Hertzian Waves in a Space Lattice."* **K. F. Lindman.** (Ann. d. Physik, 71. 6. pp. 424–426, June 14, 1923.)—The writer refers to a paper by Kapzow on the diffraction of short Hertzian waves in a space lattice, the results of which are claimed as an electromagnetic analogy with the fundamental Bragg experiments on Röntgen-ray interference in crystals. Kapzow has referred in his paper to the possibility, announced in 1914, of such experiments being carried out by the writer, but is apparently unaware of the translation of such intention into actual fact. Kapzow having found 3·5 cm. for the wave-length of the undisturbed waves and only 3·2 cm. for the reflected waves, assumed that in the measurement of wave-lengths by means of the rectilinear thermo-resonator the special period of the relatively little-damped lattice element exerted an appreciable effect on the result of the measurement. The present author has obtained similar results, and he has also determined, by variations of the wave-length, that this effect could be varied very appreciably and thereby traced to the particular period of the lattice element. The radiation emitted from the lattice was found in general to have two components, *viz.* one isochronous with the oscillations of the lattice element and a scattered or forced radiation having the same period as that of the primary waves. When the latter is smaller than that of the lattice, then the lattice radiation predominates, and when greater the two components give a corresponding displacement of the reflection maximum.

H. H. Ho.

2487. *Deviations of Electromagnetic Waves.* **R. Mesny.** (J. de Physique et le Radium, 4. pp. 129–143, April, 1923.)—Considerations on the deviations observed in wireless waves at points on the coast, and on ships during the day and at night. The author's theory, which invokes the Heaviside layer, is shown to be in general agreement with observation.

A. B. W.

2488. *Propagation of Electromagnetic Waves along an Iron Conductor.* **E. Brylinski.** (Comptes Rendus, 176. pp. 1458–1459, May 22, 1923.)—An alternative explanation of the results obtained by Laville [see Abstract 1953 (1923)] is suggested, based on the elementary theory of propagation of current along a conductor. Laville's results are considered to indicate the existence of a notable hysteresis.

A. B. C. L.

2489. *The Propagation of Undamped Electromagnetic Waves along Lines.* **G. Laville** and **E. Brylinski.** (Rev. Gén. d'Él. 13. pp. 1035–1038, June 23, 1923.)—An account of experiments with stationary waves on parallel wires 10 m. long and 2 cm. apart, frequency about 10^8, excited by a valve oscillator loosely coupled with the wires. A thermo-junction was inserted at one end and a sliding copper plate acted as a reflector at the other. Resonance curves were plotted, the abscissæ being the positions of the copper plate. From the resonance curves and the measured wave-lengths calculations were made to see if the results were in agreement with the ordinary simple laws of transmission. With copper wires the agreement was good, but not with iron wires. Brylinski's note points out that the agreement is good even with iron wires if the skin effect on both resistance and inductance be taken into account. Laville deduced from his experiments that the effects of hysteresis were negligible, but Brylinski shows that Laville's results indicate appreciable hysteresis.

G. W. O. H.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2490. *Photoelectric Action and Conduction in Crystals.* **B. Gudden** and **R. Pohl.** (Zeits. f. Physik, 16. 3. pp. 170–182, 1923.)—When two electrodes attached to the crystal are connected to a battery through a ballistic galvanometer, and the crystal is momentarily illuminated, the galvanometer throw depends on the product $N\epsilon(x_+ + x_-)/d$, where N is the number of pairs of carriers with the elementary charge ϵ, x_- is the path of the negative ϵ and x_+ that of the positive ϵ in the crystal, and d is the distance between the electrodes; for if the section of the crystal is f and n carrier pairs are formed per cm.^{3}, $N = fnd$. The division of the charges by the distance $x_+ + x_-$ corresponds to a displacement, measured by the galvanometer as a quantity of electricity, $n\epsilon f\,(x_+ + x_-) = N/fd \times \epsilon f\,(x_+ + x_1)$. If the positive "rest atoms" are practically stationary during the throw of the galvanometer, and electrons are produced uniformly throughout the crystal, the mean value of x_- will be $d/2$ and the galvanometer will give the value of $\frac{1}{2}N\epsilon$, when the so-called primary current is saturated. N is the number of electrons formed by the absorbed light energy Q, in accordance with the equation $N = Q/h\nu$, or is the quantum equivalent of Q. The positive space charge due to the "rest atoms" can be removed by means of red light, in the case of diamond, either during or after the action of the light whose photoelectric effect is being examined. In the former case the galvanometer gives very nearly the value of $N\epsilon$. Other experiments show that small quantities of electricity simply polarise the electrodes; the primary current proved to be fully reversible up to the displacement of 40×10^{-10} Coulombs, with 25 sq. mm. surface. In pure crystals of the first group, diamond, etc., the electrons travel quickly to the anode, perhaps jumping from atom to atom; the positions of the positive atoms gradually change in the electric field, under the action of thermal vibrations, or light of long wave-length, until they reach the kathode; the double layers on the electrodes persist, without external field, for several hours in the dark; they vanish in the light, owing to a reverse photoelectric current. "Pure crystals" are those in which the atoms which do not belong to the lattice do not absorb a sensible portion of the light, and cannot be shown to have any influence on the transmission of the carriers. The properties of other photoelectric crystal groups are discussed.

H. N. A.

2491. *The Electrical Conductivity of Solid Dielectrics Exposed to Röntgen Radiation.* **L. Grebe.** (Zeits. f. Physik, 17. 4–5. pp. 295–300, 1923.)—Changes in the conductivity of solid bodies when exposed to Röntgen radiation have been observed by Thomson, McClelland, Curie, Becquerel, Becker, Joffé, and Röntgen [see Abstract 712 (1921)]. The latter dealt with the case of rock-salt in his final paper, wherein he recorded an increase in conductivity. The present paper concerns the element sulphur, which exhibits an appreciable increase in conductivity growing in proportion to the intensity of the Röntgen radiation. This conductivity alters with the hardness of the rays in a similar manner to atmospheric ionisation. Monoclinic sulphur exhibits essentially higher dark conductivity than the rhombic variety, as also an appreciably greater pure radiation conductivity. Very full experimental details are included.

H. H. Ho.

2492. *Influence of Mechanical Work on the Electrical Resistance of Metals and Alloys.* **L. Guillet** and **M. Ballay.** (Rev. de Mét. 20. pp. 398–408, June, 1923.)—It is pointed out that variations of electrical resistance resulting from mechanical treatment may be classified into 4 main categories: (*a*) If a metal, previous to deformation, contains cavities, the latter are more or less closed and the apparent resistance is diminished; (*b*) with pure metals, or alloys consisting of a single homogeneous phase, the crystal grains are broken by the deformation, producing a new state with a correspondingly altered resistance. In general the resistance is increased; (*c*) the resistance of an alloy consisting of several components, being dependent partly upon the structure, can be affected independently of the part played by the special deformation of each particular constituent element; (*d*) variation of resistance of an alloy not in physico-chemical equilibrium (*e.g.* quenched) can be affected by the bringing of such an alloy into a more stable state by cold deformation. Details are given of experimental determinations of the electrical resistance of various pure metals and alloys before and after deformation, and after subsequent annealing. The resistance of worked pure metals is only slightly (less than 4 %) modified by annealing. Annealing diminishes the resistance of all the metals experimented upon except Pb and Sn, for which a slight increase is noted. On the other hand, the resistance of some alloys is strongly affected by annealing, the greatest variations being observed where the alloys are composed of a solid solution. In most cases (brasses, bronzes, aluminium bronzes), the resistance of the worked alloy is lowered by annealing, as much as 20 % in the case of some brasses. The Cu-Zn-Ni series is exceptional, the resistance of the hardened alloy being increased by annealing up to 6·5 %. The increase tends to be greater as the Cu content is lowered.

A. B. C. L.

2493. *High-Frequency Resistance of Straight Wires which are Provided with Conducting Covers.* **F. Trautmann.** (Ann. d. Physik, 72. 1. pp. 1–29, July 20, 1923.)—The paper commences with an historical account of previous work on this subject. An experimental method is then described in detail for the determination of the resistance of straight conductors for high-frequency currents. The method is then applied for different wave-lengths to conductors with metallic coatings which are provided either by electrolytic or galvanic precipitation processes so that different thicknesses can be introduced. Thin coatings of feeble conductivity (electrolytes) only occasion an appreciable increase of resistance for very short waves. Thicker layers have an unfavourable influence on longer waves. Coatings of good conducting non-ferromagnetic metals on inferior conducting non-ferromagnetic wires exhibit an improvement in conductivity but without any characteristics worthy of special note. Good conducting non-ferromagnetic covers on ferromagnetic wires show the transition of the main conduction to the coating even for very thin layers. Within a definite range of thickness the high-frequency resistance appears to be only slightly dependent on the wave-length. Ferromagnetic covers on non-ferromagnetic, but good conducting wires exhibit a very substantial addition to the resistance with the frequency. The paper is replete with experimental data.

H. H. Ho.

2494. *Galvanomagnetic Effect.* **A. Sellerio.** (Accad. Lincei, Atti, 32. pp. 549–552, June 1, 1923.)—As the space within which galvanomagnetic phenomena occur is constituted of the material of the sheet, the structure of this latter has an influence and there may be an effect normal to the common direction of the field and of the current. As in a plate parallel to the field a current in direction X produces an axial effect in direction Z [Abstract 937 (1921)], so it may be foreseen that a current Z should produce an effect X. The author has proved that this is the case by experiments with rectangular plates of bismuth in magnetic fields of force.

J. J. S.

2495. *Recent Measurements of Dielectric Losses.* **Zickner.** (Elekt. Zeits. 44. pp. 762–763, Aug. 9, 1923.)—This short paper gives a summary of recent work on the measurement of dielectric losses, chiefly at high frequencies. Owing to the shortage of mica during the war glass has been used in the construction of condensers for the transmitting apparatus of spark stations. E. Schott has made a study of a special glass—"Minoglas"—made for this purpose by the Jena Glass Works, and has examined at the same time several other dielectrics. The materials were tested by a substitution method. A measuring circuit was loosely coupled to a source of oscillations and contained the condenser to be tested in series with an adjustable inductance, the latter being varied until resonance occurs. The test condenser was then replaced by an air condenser C free from losses and a resistance ρ, these being adjusted until resonance is restored. The value of the loss-angle is then given by $\tan \delta = \rho \omega C$. The detector was a thermo-galvanometer in a circuit coupled to the measuring circuit. Various sources of error are discussed and means of correcting for them are given. The influence of chemical composition on loss-angle was examined; high alkali content produces a high loss-angle, while increasing amounts of heavy metals, such as barium or lead, reduce its value. The loss in most materials increases with frequency, measurements being made over a range from 300 to 1600 metres wave-length. Least loss occurs in crystalline bodies such as mica or rock crystal, but considerable losses may be found in organic materials such as ebonite or amber. Temperature influences have also been studied over a range of − 80° to 460° C., both as regards the changes in dielectric conductivity and constant.

In another paper [Abstract 929B (1921)] W. Steinhaus has examined the dielectric losses in resin, wax, etc., by comparing the decrement of two condensers with and without the test material respectively. W.

Geyger in a third paper has studied the losses in larger condensers, *e.g.* telephone condensers or electrolytic capacities. In his tests the condenser was connected in parallel with an air-core inductance of known resistance, the currents in the condenser, inductance, and main circuit being measured by hot-wire instruments; from the readings of the instruments sin δ is easily found. The method was applied to find the loss-angle at low frequencies. B. H.

2496. *Calculation of Self-Inductance of Coils Wound on Square Forms.* **Y. Niwa.** (Electrot. Laborat. Tokyo, Japan, Researches, No. 126. pp. 1–19, June, 1923. In English).—In 1918 (No. 73) the author published a formula; the present paper discusses its range of application and points out that an adverse criticism by Esau was due to a mistake on Esau's part. A new formula is worked out for the inductance of a solenoid with the winding concentrated at intervals. G. W. O. H.

2497. *Thermoelectric Effect in Single Metals.* **C. R. Darling** and **C. W. Stopford.** (Phys. Soc., Proc. 35. p. 215; Disc., pp. 215–216, June, 1923.)—This paper gives the results of experiments showing the existence of a large electromotive force when a temperature gradient is produced in certain homogeneous conductors (copper, graphite, constantan, iron). In the discussion it was stated that similar effects had already been described by Benedicks [Abstracts 984 (1918); 147, 1195 (1920)]. L. L.

2498. *Investigation of the Four General Galvano- and Thermo-Magnetic Effects in the same Metal Plate.* **A. Sellerio.** (Annales de Physique, 19. pp. 288–315, May–June, 1923.)—The author describes measurements of the four galvano- and thermo-magnetic effects made on the same plate of Bi, with special reference to the relation of the axial effect he has previously reported on [Abstracts 937 (1921), 387, 388 (1922), 376 (1923)] to the well-known transverse effects of Hall, Ettingshausen and Nernst, Leduc and Righi. The plate employed was of cast Bi of approximate dimensions 2·3 cm. long, 1·7 cm. wide, and 0·037 cm. thick, and showed the axial effects in a pronounced degree. The magnetic field used was 3·700 c.g.s. units. If ϕ represents the orientation of the plate ($\phi = 90°$, transverse effect) the results can be represented by the general expression:

$$e = \underbrace{\underset{\text{transverse}}{A'Hi \sin\phi} - \underset{\text{axial}}{B'Hi \cos\phi}}_{\text{principal.}} + \underset{\substack{\text{perturbation or}\\\text{dissymmetry.}}}{[a + b\cos 2(\phi - \phi_0)]H^2 i}$$

Writing the first two terms, which express the principal effect as $AHi\sin(\phi - \phi_0)$, $\tan\phi_0 = B'/A'$.

For the plate examined the following results were obtained:

	Galvano-galvanic (Hall).	Thermo-galvanic (Ettingshausen and Nernst).	Thermo-thermic (Righi and Leduc).	Galvano-thermic (Ettingshausen).
$\tan\phi_0$ ..	1	0·22	0·67	0·36

The perturbation is most marked in the galvano-galvanic and in the galvano-thermic effect and may reach to about $\frac{1}{3}$ of the total effect. In the other two effects the perturbation is small. It is known that in Bi the magnitude of the Hall constant is greater when the crystallographic axis is normal to the field and in the plane of the plate than when parallel to the field and normal to the plate. In the present plate the magnitude of the ordinary Hall constant was small, and the author concludes that the preponderating direction of the axis was inclined to the plane of the plate. L. L.

2499. *The Thomson Bridge with Alternating Current.* **E. Biffi.** (Elettrotecnica, 10. pp. 508–512, Aug. 5, 1923.)—This article deals especially with the use of the Thomson bridge for measuring the small inductances of non-inductive shunts. The method can be also used for determining the transformation ratio and the phase-angle between the primary and secondary currents in current transformers. The theory of the method and the results obtained for some shunts are given. E. B.

2500. *Measurements of Leakage Conductance.* **U. Meyer.** (Elekt. Zeits. 44. pp. 779–781, Aug. 16, 1923. From the Teleg. techn. Reichsamt.) —The object of the author is to describe a bridge method for testing imperfect condensers which will be useful in technical practice rather than in the high precision work of the laboratory. After describing briefly the usual method of comparing the capacitance and leakage conductance of a condenser with a standard condenser the author suggests as preferable the use of the Maxwell bridge. In this the imperfect condenser in one arm is compared with an adjustable inductance and resistance in the opposite arm. The two remaining arms contain fixed non-inductive resistances. The standard condenser with its accompanying troubles is therefore eliminated. The resistance of the variable inductance is compensated by a resistance connected in parallel with the test condenser; balance is obtained by adjustment of the inductance and the variable resistance in series with it. Expressions are deduced for the capacitance, leakage conductance, and loss-angle of the condenser, full account being taken of residual errors. Earth capacity troubles are removed by use of the Wagner earthing device. A discussion of the conditions for sensitive working is given, together with a complete diagram of connections of the network. The paper concludes with a description of several bridge arrangements for the direct measurement of the working capacitance of a cable, and also shows how to adapt the Maxwell bridge to enable the working leakage conductance to be determined. B. H.

2501. *Calibration of Cells for Conductance Measurements. Part II. The Intercomparison of Cell Constants.* **H. C. Parker.** (Am. Chem. Soc., J. 45. pp. 1366–1379, June, 1923.)—A new method [see Abstract 373 (1923)] is described for the accurate intercomparison of cell constants over a wide range of concentrations, and the results of four such intercomparisons are given. The effect of platinisation and the disposition of the electrodes upon a "cell constant" is rendered evident by the intercomparison curves. As the electrodes are separated the curve undergoes a gradual transition, the curve showing the most constant value being obtained with the widest separation of the electrodes. A fixed value for the derived "cell constant" is, however, obtained with none of the electrodes compared.

A new effect, somewhat similar to polarisation, is found to occur at high dilutions with cells of all the types examined; at moderate dilutions this effect amounts to at least 0·33 per cent. for one type of electrode which has been used in many accurate conductivity measurements. The existence of this effect at high dilutions is shown to be supported by the results of other investigators over a more limited range of concentrations. Correction of the existing conductivity data for this effect would tend to increase the values of the equivalent conductivity at the higher dilutions; the limiting values would probably be affected to a considerable extent, the values of the calculated degree of ionisation being reduced in like proportion. It is suggested that the effect may be due to the presence of an adsorbed layer in contact with the electrodes, the correction for the resistance in this layer being assumed to be positive or negative according as the layer contains an excess or a deficit of the conducting species. T. H. P.

2502. *The Lutz "New Form of String Electrometer."* **T. Wulf.** (Phys. Zeits. 24. pp. 299–300, July 15, 1923.)—The author points out the omission by Lutz in his paper on this subject [Abstract 1968 (1923)] of reference to the prior application, by Einthoven, of very fine silvered quartz fibres to the construction of string galvanometers, and claims for himself priority in the matter of the application of such fine fibres, mounted non-rigidly in an electric field, to the construction of a string electrometer. J. S. G. T.

2503. *The Thermo Converter.* **H. Numakura.** (Inst. El. Eng. of Japan, J. No. 421. pp. 759–767, Aug., 1923.)—Refers to the construction and character of thermo-junctions used for the measurement of small alternating currents by means of d.c. instruments. W. R. C.

2504. *Design of the Noguchi Transformer as an Audio-Frequency Source for a Kohlrausch Bridge.* **K. Noguchi.** (Inst. El. Eng. of Japan, J. No. 421. pp. 776–789, Aug., 1923.)—The core of this transformer appears to be reduced in cross-section at one point, and this part is wound with a secondary coil. Alternating current from a public main is passed through the transformer in series with a lamp, which apparently acts as a series resistance. Owing to magnetic saturation in the core where it carries the secondary winding, a peaked secondary voltage is obtained and this is used to excite the telephone-receiver of a Kohlrausch bridge. Current measurements may be made without difficulty to an accuracy of 1 in 10,000. W. R. C.

2505. *Low-Tension Kathode Ray Oscillograph.* (Rev. Gén. d'Él. 14. pp. 323–330, Sept. 8, 1923.)—A detailed account of the Western Electric Co.'s Oscillograph. [See Abstract 555 (1923).] W. R. C.

2506. *Displacements of the Capillary Electrometer for Progressive Dilutions of the Electrolyte.* **C. Barus.** (Nat. Acad. Sci., Proc. 9. pp. 156–158, May, 1923.)—Graphs showing displacements plotted against time are shown for distilled water slightly acidulated with sulphuric acid, the successive dilutions being obtained by removal of the electrolyte and replacement by distilled water. After the first dilution the displacement is somewhat enhanced and in particular a much more rapid displacement of the negative meniscus, as compared with the positive meniscus, is noted. Further dilutions cause increasing retardation of the whole phenomenon, but even in the highest dilutions the mercury surface parts with its positive ions appreciably more reluctantly than with its negative ions. These results agree with the theory of Helmholtz and Lippmann based on the 2nd law of thermodynamics. A. B. C. L.

2507. *Contact Detector as Measuring Instrument for Alternating Current.* **Angelika Székely.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 1–2. pp. 3–14, 1921.)—In a previous paper [Abstract 1173 (1922)] a discussion was given of numerous contact detectors and experiments described relating thereto. In the present paper the use of such detectors in conjunction with delicate galvanometers for measuring small alternating currents is dealt with. Experiments with a graphite-galena detector show that with suitable arrangements it is possible to measure alternating currents whose effective value is only about 10^{-6} amp. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

2508. *Production of Small Alternating Potentials of Known Amplitude.* **H. G. Möller** and **E. Schrader.** (Jahrb. d. drahtl. Tele. 22. pp. 56–72, Aug., 1923.)—In investigations of the properties of amplifiers and receiving apparatus generally, small alternating potentials are often required. These may be obtained either by potentiometer methods or by the use of coupling coils. The discussion here given of these two methods shows that the method of obtaining small alternating potentials by subdivision is open to serious objections. The method usually involves a calibration by means of direct current, which takes no account of capacity effects. The method making use of coupling coils is free from such errors, and by the use of suitable arrangements can be made very accurate. A description is given of a method giving accurate results even with very loose coupling, and suitable formulæ are derived. The effect of frequency on the coupling is discussed mathematically, and it is shown that if a two-coil apparatus is calibrated at audible frequencies it can also be used for high frequencies by the use of a simple correction term which can be easily calculated. A. W.

2509. *A Precise Method of Calculation of Skin Effect in Isolated Tubes.* **H. B. Dwight.** (Am. I.E.E., J. 42. pp. 827–831, Aug., 1923.)—Formulæ are develope demploying the ber and bei and ker and kei functions. Tables of Bessel functions are given to enable one to apply the formulæ. The results are also developed as series by which one can readily calculate a numerical example to a high degree of accuracy.

G. W. O. H.

2510. *Method of Detecting Electrical and Magnetic Disturbances.* **B. Philip.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 213–216, 1922.)—A sensitive galvanometer was connected to a cable laid round a rectangular field, the total length of conductor from the recording apparatus being about 3 miles. Observations could be made either by eye, or automatically on a moving film. Positive and negative deviations were of almost equal occurrence. Most of the records were masked by effects due to a neighbouring power line, but passing trolley cars seemed to have no effect on the deviations. Copies of records appended to the paper

show the nature of the currents induced in the cable, namely power line currents, earth currents, currents due to changes in potential and magnetic force. The cable was also used as a loop for the reception of radio waves.
G. E. A.

2511. *Instantaneous Phenomena of the D.C. Electromagnet.* **Y. Toriyama.** (Inst. El. Eng. of Japan, J. No. 421. pp. 768–775, Aug., 1923.)—The author calculates the penetration of flux into a d.c. electromagnet, on the assumption that the electromagnet is an infinitely long solid cylinder. W. R. C.

2512. *The New Model of Ewing's Ferromagnetic Induction.* **K. Honda** and **J. Okubo.** (Tôhoku Univ., Sci. Reports, 12. pp. 27–32, Feb., 1923. In English. Seventy-second Report of the Iron and Steel Research Inst.)—The authors refer to Ewing's original theory which they have treated quantitatively and have extended to include the theory of hysteresis loss and the temperature effect [see Abstracts 257 (1917) and 411 (1918)]. They discuss shortly the new model and refer to certain experimental data, and conclude that Ewing's old model explains all the observed facts quite satisfactorily, not only qualitatively but also quantitatively, and that his new model does not accord with the observed facts.
G. E. A.

2513. *The Mechanism of Magnetic Phenomena.* **J. Dorfmann.** (Zeits. f. Physik, 17. 2. pp. 98–111, 1923.)—The author tabulates Honda and Owen's gramme-atom susceptibilities for various metals and the susceptibilities of the ions as given by Pascal, and shows from their differences that in general the valency electrons of metals in the solid state increase the susceptibility of the metals in the positive or paramagnetic sense. The chromophores of organic compounds have the same effect on the susceptibility of the molecule. It is also considered that the asymmetric Faraday effect for liquid oxygen, litmus and aniline blue can be related to the paramagnetic behaviour of particular electron groups. Arkadiew's discovery of selective absorption of long electric waves by iron is discussed with the object of showing that the absorption is of a quantic nature. Taking the Curie point as that temperature at which the energy liberated during the internal magnetisation process can be immediately replaced by heat energy from the atom, the internal or molecular field is calculated and agrees with the value found by Weiss.
G. E. A.

2514. *Magnetic Properties of Ethyl Sulphate of Gadolinium at Low Temperatures.* **L. C. Jackson** and **H. K. Onnes.** (Comptes Rendus, 177. pp. 154–158, July 16, 1923. Comm. No. 168a. from the Phys. Lab., Leiden.)—The sulphate of gadolinium having been found to obey Curie's law down to 1·9° K., observations were made on the ethyl sulphate $Gd(C_2H_5SO_4)_3 \cdot 9H_2O$ which was examined in a powdered state down to 14° K. It was also found to obey Curie's law, *i.e.* the molecular susceptibility, corrected for the effect of the anion and the water of crystallisation, when multiplied by the absolute temperature, gives a constant product. This effect is explained as being due to the state of great magnetic dilution of the substance and to the consequent feeble intermolecular field. The number of magnetons deduced for the substance is 37·3, which is comparable with 37·91 found by Cabrera. Examination of a series of crystals of ethyl sulphate of gadolinium verifies the supposition that this crystal is magnetically isotropic although belonging to the hexagonal system. [See also Abstract 119 (1915).] G. E. A.

2515. *The Relations between Field Strength, Coercive Force, and Remanence.* **J. Würschmidt.** (Zeits. f. Physik, 16. 3. pp. 203–208, 1923.)—The author shows that if the coercive force has a value in the neighbourhood of 75, a field strength of 300 Gauss is sufficient for its accurate determination: if the coercive force has a value in the neighbourhood of 160, a field strength of 600 Gauss is required. Gumlich has shown that for a coercive force of 220, a field strength of 1100 Gauss is necessary. The field strengths should be slightly higher to obtain the true values of the remanence. Krupp's alloy, containing steel, cobalt, manganese, and chromium, is being manufactured under the name of "Koerzit." W. H. S.

2516. *Magnetic Properties of Sheet Steel under Superposed Alternating Field, and Unsymmetrical Hysteresis Losses.* **Y. Niwa** and **Y. Asami.** (Electrot. Laborat. Tokyo, Japan, Researches, No. 124. pp. 1–25, June, 1923. In English.)—The material tested was very thin silicon steel sheet made into a ring containing 100 insulated strips and wound with two coils, one for d.c. and the other for a.c. at a frequency of 50. The ring also carried three search coils connected respectively to an a.c. voltmeter, a wattmeter, and a fluxmeter. On testing the effect of the superposed alternating field on the d.c. permeability, it is found that when the d.c. magnetising force is small, the a.c. promotes magnetisation along the ascending and demagnetisation along the descending stage of the hysteresis loop, the change depending on B_m the amplitude of the alternating field, and on H. When H is large, hysteresis is reduced, the loops being almost suppressed in some instances. The variation of unsymmetrical hysteresis losses with the magnetising force of the superposed a.c. is parabolic for a constant amplitude of pulsation of induction. The unsymmetrical hysteresis loss increases with the induction of d.c. magnetisation to a maximum, after which it decreases. Ball's formula for hysteresis loss is found to hold to within 10 per cent., the values being $\epsilon = 0 \cdot 136 + 1 \cdot 14 \times 10^{-3} B_{d.c.}^{1 \cdot 9}$ where ϵ is the factor in Steinmetz's equation, but is not a constant for these experiments. The results are contained in numerous tables and curves. G. E. A.

2517. *On the Magnetic Hardness of Quenched Steels.* **T. Matsushita.** (Tôhoku Univ., Sci. Reports, 11. pp. 471–485, Dec., 1922. In English.)—L. W. Wild [Abstract 315 (1921)] has stated that the magnetic hardness can be used as a test of the quenched state of steel and over a much larger range than the Shore and Brinell tests. In the present paper the author gives results of the measurement of the coercive force of eleven carbon steels (from 0·28 % C. to 1·5 % C) for variation in quenching temperature from about 740° C. to 1000° C. As the quenching temperature passes through the A_1 point the magnetic hardness rapidly increases, attains a maximum, and then gradually decreases. The amount of the decrease increases with the C content. The maximum coercive force is found to increase with the C content up to about 1 % and then gradually diminishes. The effect of the nature of the quenching liquid was also studied. The addition of common salt (3 %) to water slightly increases the quenching power. Raising the temperature of the water (18° to 38°), slightly decreases its quenching power. The addition of soap (0·1 % to 0·3 %) to the water diminishes its quenching power. Below 850°, the magnetic hardness of a high carbon steel quenched in oil is considerably less than the same steel quenched in water, but above 900° the hardness in the case of oil quenching is considerably greater. The duration of time, during which the quenching temperature is maintained does not affect the hardness. In the case of alloy steels oil quenching generally produces a greater hardness than water quenching. L. L.

2518. *The Magnetic Testing of Steels under Load. Elastic Limits.* **L. Fraichet.** (Rev. de Mét. 20. pp. 549–559, Aug., 1923.)—This paper is similar to that referred to in Abstract 1984 (1923), but more extended. The magnetic diagram is found to be capable of giving information on the relationship between magnetic phenomena and temper. This method of testing is claimed to possess great advantages for industrial purposes. An appendix deals with the correspondence of the points of inflection of the curve at the elastic limits. H. H. Ho.

2519. *The Effect of Quenching from above the Carbide Transition Temperature upon the Magnetism of Steel.* **A. A. Dee.** (Roy. Soc., Proc. 104. pp. 316–321, Sept. 1, 1923.)—Thompson and Whitehead [Abstract 1257 (1923)] have suggested from the difference of electrical resistance and etching properties that the sudden cooling from 300° C. of carbon steel leads to the suppression of the carbide change. If such is the case sudden quenching should materially alter the magnetic properties. To test this the author has carried out the following tests on annealed C steel (C = 1·1 %).

(1) The initial part of the I–H curve for a rod was determined (*a*) after slow cooling, (*b*) after quenching from 300° C. in ice-cold water. No appreciable difference in the curves is noticeable.

(2) The residual magnetism of the same rod was measured after application of a suitable field and at various temperatures up to about 260° C. The results are the same whether the rod has been slowly cooled or quickly quenched. In both cases there is a sharp fall in the effect at 210° C. associated with the transition of the carbide. Rods of pure iron show no such effect in this region of temperature.

(3) The rod was heated to 300° C. and then carried through a demagnetising cycle. A field of 4·1 c.g.s. units was applied and the specimen allowed to cool at various rates (270° to 170° in 1hr., 270° to 170° in 8m., 240° to 140° in 3m.), the magnetisation being measured at intervals. The curves are practically identical for all cases.

The author concludes that if one takes magnetic properties of cementite as a criterion of its transformation, then rapid cooling does not retard it to an appreciable extent. This result is also confirmed by the measurements of the permeability of a ring of C steel (C 1·5 %), carried out by W. V. Mayneord, which was subjected to similar heat treatment. L. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2520. *Industrial Adsorption of Gas and Vapours with Activated Carbon.* **A. B. Ray.** (Chem. and Met. Eng. 29. pp. 354–359, Aug. 27, 1923.)—Among the essential characters of gas-adsorbing carbons are sufficient mechanical strength to withstand the crushing and abrading action to which it is subjected during use and transport, and a relatively high apparent density. Activated carbon holds gases and vapours in two different ways: the total sorptive capacity or "saturation value" is determined by exposing the dried and evacuated carbon in an excess of the pure vapour at, say, a temperature of 25°, whereas the amount retained when the saturated carbon is moderately heated and evacuated is a measure of the specific attractive forces or retentivity; the difference between these values represents the vapour held loosely by capillary action.

Experimental results obtained show that, by reason of its larger total and specific adsorptive capacity, activated carbon is markedly superior to silica gel for recovering such a vapour as benzene present in high concentration in dry air. Moreover, when water vapour is present together with a hydrocarbon vapour, the silica gel becomes saturated with the water vapour in preference to the hydrocarbon vapour, whereas the reverse is the case with the carbon. For the effective removal from the carbon of substances with low boiling-points, such as the various gaseous hydrocarbons and volatile solvents, the steam or water used need not be over 100°, the idea that superheated steam is necessary for the elimination of such substances as natural-gas gasolene and benzene being erroneous.

In addition to its use for the separation and recovery of gases and vapours, activated carbon may be used for the purification of gases, for the storage of gases, as a catalyst, and for the production of high vacua.
T. H. P.

2521. *Two-Film Theory of Gas Absorption.* **W. G. Whitman.** (Chem. and Met. Eng. 29. pp. 146–148, July 23, 1923.)—The rate of absorption of a gas by a liquid is controlled by the rate of diffusion of the gas through the surface films at the gas-liquid boundary. According to one theory, the diffusion occurs through a gas film and is actuated by a difference in the partial pressure of the solute at the outside and inside of the film, whereas others consider that diffusion takes place through a liquid film on the surface of the main body of liquid and is controlled by a difference in concentration between the outside of the film and the inside. The author shows that a more satisfactory representation of the process is obtained on the assumption that the rate of diffusion is controlled by two surface films, an exterior gas film surrounding the liquid, and a liquid gas film on the surface of the liquid. Confirmation of this conclusion is afforded by the results of experiments on the absorption of hydrogen chloride in water at 30°.
T. H. P.

2522. *Effect of Long Grinding on Quartz* (*Silver Sand*). **R. C. Ray.** (Roy. Soc., Proc. 102. pp. 640–642, Feb. 1, 1923.)—It has previously been shown from determination of the heats of solution that when silver sand is subjected to grinding for a long time in a mechanically operated agate mortar it partially loses its crystalline structure and is converted into the vitreous state [Abstract 385 (1923)]. The difference between the molecular heats of solution of quartz and vitreous silica indicated that 31·2 % of the material is converted into the vitreous state by 15 hours' grinding. The experiments described in the present paper were undertaken to test the suggestion that a measurement of the densities of the ground and unground materials ought to show a difference if any considerable change takes place. It is found that the density of the ground substance is lower than that of the unground. The fall of density shows that as much as 25·7 % of the material is converted from the crystalline to the vitreous state after 15 hours' grinding. This value agrees fairly with that arrived at from the determination of the molecular heats of solution. T. H.

2523. *Sintering: Its Nature and Cause.* **R. C. Smith.** (Chem. Soc., J. 123. pp. 2088–2094, Aug., 1923.)—Sintering of platinum black, and other finely divided metals [Abstract 1199 (1922)] may be due either to the lowered melting point of the small particle and thus connected with the phenomenon of its increased vapour pressure, or to a change in structure from amorphous to crystalline, from one crystalline form to another, or from one size of particle to another. The results of previous investigators, together with the experimental evidence now advanced, show that sintering may take place in crystalline and in amorphous substances, that the sintering of a crystalline substance is due to a change in the size of the crystals or to the formation of an allotropic modification, and that the sintering of an amorphous substance is due to the formation and growth of crystals (Beilby's pulsation cell theory). T. H. P.

2524. *Isotopes: New Relation Concerning the Periodic System of the Atomic Species.* **W. D. Harkins.** (Am. Chem. Soc., J. 45. pp. 1426–1433, June, 1923.)—The periodic system of the atomic species developed by the author [Abstract 1041 (1917)] may be represented most simply as a double network of lines, atomic species existing only at the intersections of the lines. The simplest double network is given if the atomic number is plotted on one axis and the isotopic number on the other. In this case a double network of squares is obtained, with alternate heavy and light lines in both directions. Most of the atomic species, and also the most abundant atomic species, occur where both variables are even numbers, that is, where heavy lines intersect; the next most favourable type of intersection is that between light lines, where both variables are odd. A moderate number of species of even atomic number (and atomic weight) occur, but in general these are not abundant. The occurrence of these species is related in a very direct way to that of odd atomic and isotopic number (and atomic weight), since, when the atomic weight is not too high, each species of odd atomic weight but even atomic number usually lies on the same line of constant isotopic number as, and directly between, two atomic species of odd atomic and isotopic numbers (and odd atomic weight); in the region of atomic weight 50 this condition is less exacting.

Species of even atomic weight mostly exist at the intersection of heavy lines, where both the atomic and isotopic numbers are even. For atomic numbers above 28, that is, in the region of abundant isotopes, this gives a network of squares, continuous in general within the region of stability, and with from four to seven levels in the vertical or n direction. The general form of the region of stability is that of a hyperbolic band tangential to the M-axis at the origin. The species of odd atomic weight form a pattern of their own, on the whole like a single set of steps. In certain limited regions, one step lies directly over another, but the number of overlying steps is considerably less than for those representing the species of even atomic weight.

Attention is drawn to a periodicity of 2 in the number of nuclear negative electrons, and a somewhat less prominent periodicity of 2 in the number of protons. In both of these, even numbers predominate over odd in both number of species and in their abundance. A periodicity of 2 is observed also in the relative negativeness of the nucleus. For constant even isotopic number the general difference between adjacent atomic species is one α-particle or p_4e_2. For odd isotopic number (and atomic weight) the most common difference is half an α-particle or p_2e, although the difference of a whole α-particle often occurs also. Hypotheses concerning both of these relations are discussed. The existence of a considerable number of hitherto undiscovered atomic species (isotopes) is predicted. T. H. P.

2525. *Rutherford's X_3 and the Deviation from Coulomb's Law in Close Proximity to Elementary Electrical Charges.* **A. Smekal.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 3–4. pp. 149–157, 1921.)—An upper limit has previously been found by the author for the atomic weight of a possible isotope of hydrogen, $H^{(2)}$, the nucleus of which contains two protons and one electron. This excludes the possibility that the nuclei of C, N, and O contain $H^{(2)}$ particles. If one calculates from the atomic weights of N and O, with assumptions which agree with experiment, first an atomic weight for $H^{(2)}$, assuming it forms part of the nuclei, and then an atomic weight for X_3, with a similar assumption about this isotope of helium ($N = 4X_3 + 2H$, $O = 4X_3 + He$), then the resulting deviations from Coulomb's law only agree in a satisfactory manner with the results obtained from a consideration of the α-particles in the case of X_3. With the help of the results obtained from X_3 the upper limit of the atomic weight of $H^{(2)}$ can be fixed more sharply. The assumption of the existence of an isotope of lithium, with mass 4, which cannot altogether be excluded as far as the atomic model is concerned, leads to a very small cohesion energy for the hypothetical atomic nucleus. H. N. A.

2526. *Action of Silica on Electrolytes.* **A. F. Joseph** and **J. S. Hancock.** (Chem. Soc., J. 123. pp. 2022–2025, Aug., 1923.)—When silica is added to a solution of a simple electrolyte, such as sodium chloride, a change takes place which is shown by the solution becoming acid. This effect appears to be due to a chemical transformation resulting in the formation of free acid and of a complex silicate of low solubility but alkaline reaction. Pure silica has no influence on a solution of an acid, the reduction of the acidity usually observed occurring only when the silica has not been well purified. T. H. P.

2527. *Catalytic Action of Colloids in Corrosion.* **J. K. Wood.** (Chem. and Met. Eng. 29. pp. 188–192, July 30, 1923).—Mainly a discussion of Friend's colloidal theory of the corrosion of iron. T. H. P.

2528. *Spherically Surfaced Double Layers in Liquids Containing Ions.* **A. Gyemant.** (Zeits. f. Physik, 17. 3. pp. 190–201, 1923.)—The electric charge which the disperse particles of a colloidal solution exhibit towards the solvent makes the existence of such solutions not only possible, but plays an important function in all processes in which the solution is engaged. For further elucidation the assumption of an ionic spherical shell is adopted and an investigation made of the magnitude of the surface charge for given particles and given solvents. A differential equation is derived for the distribution of the potential of such double-layer spherical shells in ion containing solutions, which equation, however, does not admit of a general integration. For certain limiting cases, however, an approximate solution may be found whose practical agreement has been demonstrated. The expression so obtained for the potential relation finds application in many colloidal problems, and a calculation is included of the thickness of the double layer from a given potential distribution and ionic concentration. The problem is also discussed of the dependence of the electro-kinetic potential due to cataphoresis on the ionic concentration. H. H. Ho.

2529. *Corrosion of Non-Ferrous Metals.* **W. Fraenkel.** (Zeits. f. Metallkunde, 15. pp. 91–97, April, and Disc., pp. 161–163, June, 1923.)—The paper is a lecture on the corrosion of non-ferrous metals delivered before the Deutschen Gesellschaft für Metallkunde in 1922. The broad question of non-ferrous corrosion is discussed, and the possibility of laboratory experiments as a guide to the behaviour of metals is put forward. The paper is not suitable for abstracting. F. J. B.

2530. *Demonstration of the Shifting of the Boundary between Crystallites.* **R. Vogel.** (Zeits. Elektrochem. 29. pp. 301–303, July 1, 1923.)—A strip of polished sheet cadmium is etched with 5 % HNO_3, and examined with a projection microscope. It is heated quickly at the back with a very small blow-lamp, and suddenly a new network appears, showing that much larger crystallites are produced than the original ones; these originate from the fact that some of the original small crystals have compelled whole groups of neighbours to assume their orientation; in other words, each of them has quickly grown, and consumed its neighbours. In some cases a crystal may grow on one side and be consumed on another, so that the relation between the original and final network may be somewhat complicated. The author has come to the conclusion, from his observations, that if two crystallites touch one another in a conglomerate, the atomic distances will in general be smaller in the bounding surface for one of them, and in consequence of this the boundary atoms will be held in the equilibrium positions of their respective lattices with unequal forces. The atoms are most densely distributed in the octahedron planes, less densely in the cube surfaces, and still less densely in the rhombic dodecahedron faces. If two crystallites touch with faces of the first and third kind in contact, the first will grow at the expense of the other when they are heated; and similarly for those with faces of the first and second, and of the second and third kinds. H. N. A.

2531. *Alteration in Metal Structure by Cold Working.* **M. Polányi.** (Zeits. f. Physik, 17. 1. pp. 42–53, 1923.)—The author retains the assumption that the mechanism by means of which the change of orientation of a stretched zinc, single-crystal wire is carried on also causes the change of orientation of the crystallites when a polycrystal is deformed; and the principle that each crystallite, as a unit, behaves itself, when the metal is deformed, as if it alone were subject to an equal deformation; also that when the stretching is continued the gliding direction concerned sets itself at a constantly smaller angle to the direction of stretching. A new consideration is introduced, namely that, with cubical lattices, the different possible gliding directions can, as it were, compete with one another. If there are two such directions, I and II, they may alternately approach the axis of the wire; and these movements take place in the plane of the axis of the wire and the gliding direction concerned. If sliding along I, with the resulting approach of this direction to the axis of the wire, and the resulting departure of II from this axis, favours the sliding along II as compared with that along I, the configuration produced is stable, and a lattice position results in which the axis of the wire coincides with the line bisecting the angle between two diagonals of the cube faces. The observed fibrous structure can be explained on the plausible assumption that sliding takes place most easily when the angle between the force and the sliding direction is somewhat greater than 45°. The structures of metal foils are explained as follows: The process of rolling is compounded of a pressure, normal to the plane of rolling, and a pushing action in the direction of rolling; a gliding surface takes part best in the action, when its angle with the plane of rolling is 45°; a gliding direction works the better, the smaller the angle which it makes with the plane of greatest push. The experimental material is not sufficient to give certainty to the conclusions drawn; it will be possible to correct them in accordance with the line of thought indicated, if this proves necessary. The original paper discusses previous observations in detail. H. N. A.

2532. *Dilatometric Study of the Transformations in Carbon Steels.* **S. Konno.** (Tôhoku Univ., Sci. Reports, 12. pp. 127–136, April, 1923. Seventy-fourth Report of the Iron and Steel Research Inst.)—A modified form of Chevenard dilatometer is described, and the results are given for a series of determinations of the temperature and magnitude of the A_1 and A_3 transformations in steels having a carbon content ranging from 0·03 to 1·4%. The curves consist of four branches, corresponding to the differential dilatation of pearlite and of austenite with respect to the neutral body, the eutectoid transformation, and the solution of the remaining cemetite or ferrite. The paper concludes with a discussion of Honda's theory of the A_1 transformation in the light of the results obtained with the dilatometer. J. L. H.

2533. *Hardness of Metals as Affected by Temperature.* **K. Itô.** (Tôhoku Univ., Sci. Reports, 12. pp. 137–148, April, 1923. Seventy-fifth Report of the Iron and Steel Research Inst.)—Hardness measurements were made to metals and alloys at temperatures varying between $-50°$ C. and 150° C., the temperatures being obtained by carrying out the tests in a bath of petroleum, water, or glycerine, according to the temperature required. *Results.*—In every case it was found that the relationship between hardness and temperature could be expressed by the formula: $\log H_2 - \log H_1 = a(t_2 - t_1)$ where H_2 and H_1 are the Brinell hardnesses at the temperatures t_2 and t_1 and a is the tangent of the inclination of the straight line, *i.e.* the temperature coefficient of the hardness. It was also found that in the case of pure metals, α and the melting-point are connected by the formula $T(\alpha + 0{\cdot}00145) = 2{\cdot}5$ where T is the melting-point in deg. abs. J. L. H.

2534. *Light Alloys, Free from Magnesium, having a High Tensile Strength.* **A. Portevin** and **F. le Chatelier.** (Comptes Rendus, 177. pp. 311–313, July 30, 1923.)—A discussion of the effect of quenching and annealing on the mechanical properties of an alloy containing 4·3 % Cn, 0·8 % Mn, and 0·33 % Si, and a comparison with alloys of the duralumin type. This alloy quenched at 525° C. and annealed at 110° C. (after rolling) gives a tensile strength of 45 kg. per sq. mm., with an elongation of 20 % and has the advantage over the duralumin type of alloy, that spontaneous hardening does not take place. Tensile strengths of over 30 kg. per sq. mm. with elongations of 5 % can be obtained on cast alloys of this type, by suitable heat treatment. J. L. H.

2535. *Equilibrium of Steam in the Presence of Iron and Tungsten and their Oxides.* **L. Wöhler** and **R. Günther.** (Zeits. Elektrochem. 29. pp. 276–285, June 1, 1923.)—Results are given of measurements on the equilibrium of iron and steam in the presence of the phases Fe/FeO, FeO/Fe_3O_4, and Fe_3O_4/Fe_2O_3, both by oxidation and by reduction. As was found by van Groningen (1921) and by Chaudron (1921), below 570° the value of K_2 for Fe_3O_4/FeO and that of K_3 for FeO/Fe are identical. The quadruple point of the system $Fe/FeO/Fe_3O_4/O_2$, below which FeO is no longer stable and decomposes into Fe and Fe_3O_4, hence lies at 570°. From the logarithmic representation of the values found for K the general equations of the reaction isochore of the form $\log K = -Q/4{\cdot}571\,T + C$ are derived for the three systems. By combination of these equations with the equation for the dissociation of water, general equations are derived for the dissociation equilibria of the iron oxides, and from these calculations are made for the pressure of the oxygen at certain temperatures and for the heats of formation of the various oxides. The e.m.f. of the oxidation cells FeO/Fe and Fe_3O_4/FeO are calculated by means of the formula $E = \frac{0{\cdot}0002}{4}\,T \log \frac{p_1}{p_2}$, the results agreeing well with those obtained by Treadwell (Zeits. Elektrochem. 22. p. 414, 1916). Under certain conditions, which are detailed, it is possible to reduce ferric oxide to pure ferrous oxide by a mixture of steam and hydrogen. Below 560° it is possible to reduce Fe_3O_4 only to metallic iron.

A method is described of preparing pure tungsten dioxide and pentoxide, these being used to determine the equilibrium constants of steam with the phases WO_3/W_2O_5, W_2O_5/WO_2, and WO_2/W. The equations for the respective isochores are: $\log K_1 = -\frac{1375}{T} + 2{\cdot}235$, $\log K_2 = -\frac{1000}{T} + 1{\cdot}218$, and $\log K_3 = -\frac{1904}{T} + 1{\cdot}554$. General equations are deduced for the dissociation equilibria of the tungsten oxides and the pressure of the oxygen at various temperatures calculated. T. H. P.

2536. *The Free Energy and Heat of Formation of Zinc Iodide.* **T. J. Webb.** (J. Phys. Chem. 27. pp. 448–454, May, 1923.)—A study has been made of the cell, Ag-AgI ZnI_2 (Sat. soln.)/–Zn-amalgam. Its e.m.f.

at 25° was found to be 0·39872 volt, and its temperature coefficient − 0·000094 volt per degree. Employing these data and the value of the heat of formation of silver iodide (15·1 kg. cals.) the heat of formation of zinc iodide has been found to be 49·9 kg. calories. A direct calorimetric determination has also been made. The value thus obtained was 49·8 kg. calories. The agreement is considered satisfactory. AUTHOR.

2537. *The Superposition of Electromotive Forces in Columns of Fluorescent Liquid.* **A. Grumbach.** (Comptes Rendus, 177. pp. 395–398, Aug. 6, 1923.)—The author has previously found [see Abstract 1262 (1923)] that the electromotive force produced by the illumination of a coloured solution in which two platinum electrodes are immersed, does not exhibit the characteristics of the Becquerel effect unless the concentration is very great. The present paper now shows there to be a superposition of 2 distinct phenomena. If the light beam be converged on one of the electrodes, the illuminated region being sufficiently narrow (2 to 3 mm.), the positive effect predominates at the outset of the experiment, but the electromotive force passes through a maximum and becomes negative at the end of a period which may attain several hours in concentrated solution. A negative phenomenon is observed by illuminating in the same way a region of liquid saturated, for example, at 15 mm. from the electrode. This second e.m.f. in contrast to the former does not diminish rapidly in absolute value in the dark. Monochromatic light was employed from a mercury lamp, and the experiments were carried out with solutions of the sodium salt of fluorescein. Tables of data are included from which the positive phenomenon is found to be very feeble in dilute solutions. Swensson's work with mineral salts is briefly discussed in the concluding paragraph. H. H. Ho.

2538. *Liquid Chlorine as an Ionising Solvent.* **J. Mennie** and **D. McIntosh.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 301–305, 1922.)—The observations of Johnson and McIntosh [Abstract 2143 (1909)] on liquid chlorine as an ionising solvent are confirmed. Not one of the ordinary organic compounds or of the 180 inorganic compounds examined undergoes ionisation in this solvent. Ether, alcohol, acetone , and ethyl acetate form conducting solutions on addition of hydrochloric acid, the conductivity increasing as a rule with the proportion of acid. With alcohol, which is a poor conductor, a rapid increase, a sudden drop, and a gradual increase in conductivity occur successively as acid is gradually added. As the conducting substance is probably polymerised in solution, this variation in the conductivity may be attributed to variation, with the concentration of the acid, of the relative rates of association and dissociation. The results of the measurements made indicate that the conduction is the result of ionisation of an oxonium acid compound by the acid, the chlorine merely increasing the resistance. Since a measurable interval of time is probably necessary to bring about equilibrium between the undissociated chlorine compound and the acid the increase in conduction is to be expected.

Measurement, under similar conditions, of the conductivity of a solution of acetone with toluene substituted for the chlorine gives results considerably lower than with the corresponding chlorine solution, but the general slope of the curve is the same and indicates similar functions in the two cases. T. H. P.

2539. *Ionisation of Alcohols.* **R. J. Williams and R. W. Truesdall.** (Am. Chem. Soc., J. 45. pp. 1348–1353, June, 1923.)—In order to determine the degree of ionisation of ethyl alcohol into hydrogen and ethoxide by investigation of the equilibrium point in the reaction,

$$C_2H_5 . OH + NaOH \rightleftarrows C_2H_5 . ONa + H_2O,$$

a dynamic method, accurate to about 10 per cent., has been devised for estimating very small amounts of water in alcohol without disturbing the equilibrium appreciably. A known amount of the liquid was shaken with a sample of known weight of specially prepared granular calcium carbide for a definite length of time, so that only a small proportion (about 4 per cent.) of the water actually present was used up. This amount was sufficient to allow of a nephelometric determination of the calcium in suspension as hydroxide, comparison being made with the action of similar carbide on alcohol containing known amounts of water. Results obtained in this way indicate that alcohol is about 8 per cent. as highly ionised as water, but the nature of the method employed renders this result too high. The value obtained by Danner and Hildebrand [Abstract 597 (1923)] for the degree of ionisation of alcohol by the conductivity method must, therefore, be too high, but that given by potential measurements is reasonable.

On the assumption that esterification is a neutralisation reaction, the available data for the equilibrium constants of the reaction between alcohol and hydrogen chloride indicate the basic strength of alcohol to be zero. Investigations of the action of methyl alcohol on magnesium nitride, calcium hydride, Grignard reagents, and calcium carbide show that alcohols ionise in only one way, namely, as feeble acids. T. H. P.

2540. *Electrolytic Solution and Deposition of Copper.* **T. R. Briggs.** (Am. Electrochem. Soc., Trans. 40. pp. 231–244, 1921.)—The author modifies the theory formulated by Luther and concludes that the electrolytic behaviour of copper in solutions containing copper ions may be accounted for by two electrochemical reactions (or their reverse):

$$(1)\ Cu + \oplus \longrightarrow Cu^+, \quad (2)\ Cu^+ + \oplus \longrightarrow Cu^{++}.$$

The cuprous ions formed at the anode may be removed by electrolytic oxidation or by chemical means, in which respective cases the copper dissolves as a bivalent and as a univalent metal. Similarly cuprous ions may be supplied at the kathode by electrolytic reduction of cupric ions or by chemical means, in which respective cases copper is deposited as a bivalent and as a univalent metal. If conditions are partly electrolytic and partly chemical the copper dissolves and is deposited with an apparent valence which lies between 1 and 2. The theory advanced is applicable in general to metals other than copper. AUTHOR.

2541. *Theory of Electrolytes. Part II. Law of the Limit of Electrolytic Conductivity.* **P. Debye and E. Hückel.** (Phys. Zeits. 24. pp. 305–325, Aug. 1, 1923.)—As it had proved impossible to express the conductivity curve as a function of the concentration by the aid of the mass law [Abstract 2328 (1923)], a conductivity coefficient f_γ had been introduced such that $\Lambda = f_\gamma \Lambda_0$ where Λ_0 indicates the conductivity limit for vanishing concentration. At very small concentrations all the conductivity curves show a marked curvature instead of approaching concentration zero in a straight line. Kohlrausch gave the approximate formula $1 - f_{\gamma} \sim c^{1/3}$; the formula is often quoted in a general sense, but Kohlrausch only proposed it for interpolations and pointed out that at low concentration the power exponent should be 1/2 (not 1/3). The authors confirm this square-root rule. Their mathematical deductions concern low concentrations and the influence of the electric forces of the ions on the conductivity. In a pure solvent an ion would, under the exclusive influence of an external field, travel with a velocity at which the friction balances the field. As the concentration increases, Coulomb forces between the ions come into play, and the friction is altered by the presence of other ions; both these effects, which are connected with the density of the ionic atmosphere, tend to decrease the conductivity, in accordance with the Kohlrausch $c^{1/2}$ rule. Similar considerations had been set forth by P. Hertz [Abstract 958 (1912)] and by Ghosh (criticised in Part I), neither of whom explained the square root rule. The authors discuss the distribution of potential, field and charge about an ion in motion, and the electro-phoretic forces which, like the ionic forces, are important already at small concentrations, for aqueous and non-aqueous solutions, and test the formulæ deduced by reference to the experimental data, mainly of Kohlrausch, Weiland [Abstract 433 (1918)], and Walden (Zeits. anorg. Chem. 115. p. 49, 1920). In the case of ammonium salts, TlF and some other salts, Kohlrausch had observed an unexpected conductivity maximum which he did not trust; the experiments of Kraus and Parker [Abstract 411 (1923)], made in various vessels, show that the maximum becomes less distinct, though it does not quite vanish, when quartz vessels are used instead of glass vessels. The agreement between the formulæ and experiment is unsatisfactory in the case of salts like magnesium sulphate when both the ions are bivalent. As regards the temperature coefficient of conductivity the experimental data available are insufficient. H. B.

2542. *Electrolytic Conduction: Theory of Residual Affinity.* **H. E. Armstrong.** (Roy. Soc., Proc. 103. pp. 619–621, July 2, 1923.)—In discussing the phenomena of electrolytic conduction (Roy. Soc., Proc. 40. p. 268, 1886) the author drew a distinction between simple and composite electrolytes, the former being salts, such as the silver haloids, and the latter mixtures of compounds which are themselves dielectrics. Only metallic salts of certain types are simple electrolytes, no per-salt, for instance, being a conductor. From the results which have been published in the meantime it is evident that the structure of salts is the determining factor as regards their conductivity. It was found by Tubandt (Zeits. anorg. Chem. 115. p. 105, 1921) that, in the heated solid state, silver iodide, bromide, chloride and fluoride, and lead chloride and fluoride are good conductors and strictly obey Faraday's law, but whereas the silver compounds are so affected that silver is deposited at the one, and withdrawn from the other, electrode in equal amounts, the lead haloids abandon halogen to the one electrode and take it from the other. These differences are assumed to depend on structural differences, which may also serve to explain the electrolysis of aqueous solutions. T. H. P.